

New Brunswick Department of Health

in cooperation with the

**Nova Scotia Department of Health
is pleased to sponsor the**

Certification Program in Insulin Dose Adjustment

**Developed by the
Diabetes Care Program of Nova Scotia**



Acknowledgements – New Brunswick

We would like to offer our sincere appreciation to the Diabetes Care Program of Nova Scotia (DCPNS) and the Nova Scotia Department of Health for their willingness to share this comprehensive resource.

The DCPNS continues to be a leader across Canada in the development of tools and processes to support certified diabetes educators. We are grateful to be able to benefit from the expertise and lessons learned as reflected in this latest version of the training program. We look forward to ongoing opportunities to collaborate and share resources to address the epidemic of diabetes across Atlantic Canada.

We are very pleased to offer this resource and education program to certified diabetes educators, who are instrumental in helping patients understand and learn how to manage this lifelong chronic condition. We believe that this certification program will support diabetes educators in reaching and maintaining an expected level of competence in performing insulin dose adjustment as a delegated medical function within the health care team and enhance the circle of care available to support persons living with diabetes.

We hope that you will find this program useful in your practice and again thank you for your commitment to improving the health of New Brunswickers.

Regards,

Chronic Disease Prevention Management Unit

Department of Health

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Members of the Delegated Medical Function Committee

- Carrie Haggett, RN BScN CDE, Chair
- Bev Harris, PDt CDE
- Catherine Splane, RN BComm CDE
- Sheilagh Crowley, RN BN CDE
- Peggy Dunbar, MEd PDt CDE, Co-Chair
- Lois Ferguson, RN BScN CDE
- Shawna Boudreau, BScN RN CDE
- Kim Kelly, BSc. Pharm

Medical Advisors for the Delegated Medical Function Committee (2015)

- Beth Cummings, MD FRCPC, Pediatric Endocrinology IWK Health Centre, and Medical Advisor, Diabetes Care Program of Nova Scotia, Halifax, NS
- Angela McGibbon, MD PhD FRCPC FACP, Endocrinology Horizon Health Network, Fredericton, NB
- Barna Tugwell, MD FRCPC, Adult Division of Endocrinology QEII Health Sciences Centre, Halifax, NS
- Churn-Ern Yip, MD FRCPC, Adult Division of Endocrinology QEII Health Sciences Centre, Halifax, NS
- Lenley Adams, MD FRCPC, Internal Medicine, Charlottetown Medical Director PEI Provincial Diabetes Program
- Tom Ransom, MD FRCPC, Adult Division of Endocrinology QEII Health Sciences Centre, Halifax, NS

Administrative Support and Editing

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Introduction

This manual has been developed by the Diabetes Care Program of Nova Scotia (DCPNS) to assist and facilitate the practice of insulin dose adjustment as a Care Directive (or Delegated Function) in Nova Scotia Diabetes Centres (DCs), and Diabetes Programs in our partner provinces Prince Edward Island, **New Brunswick (as a medical directive with Horizon Health Network and a delegated function with Vitalité Health Network)** and the Western Region of Newfoundland. It has been developed to provide standardized policies and guidelines. It provides diabetes educators (nurses and dietitians) with policies, procedures, and guidelines to assist them in reaching and maintaining an expected level of competence in performing insulin dose adjustment.

Current diabetes management focuses on optimal metabolic control.¹⁻⁷ Achieving the best possible glycemic control requires the active participation of the person with diabetes in making adjustments to their meal plan, physical activity routine, and insulin doses. This requires knowledge and skill acquisition and the motivation to carry out self-care practices. The diabetes educator, who is certified in insulin dose adjustment, can teach and assist clients to safely and competently adjust their insulin doses to achieve the most appropriate glycemic targets as per the Canadian Diabetes Association Clinical Practice Guidelines.⁵ The diabetes educator's ability to adjust insulin is a considerable asset to both the client and referring physician.

It is expected that the diabetes educator will master insulin dose adjustments for adults prior to proceeding to dose adjustments for specialty populations. Only diabetes educators involved with the care/education of clients in the specialty areas (i.e., pregnancy, children/adolescents, and pump therapy) will be expected to make dose adjustment recommendations for these populations. As a prerequisite to adjusting insulin for pump therapy, it is recommended that the diabetes educator be certified as a pump trainer as well as certified in insulin dose adjustment.

This is a living document. New reference tables will be generated in keeping with new and evolving therapies/practices.

These guidelines support insulin dose adjustment. They provide guidance for all insulins (the newer and older) as this reflects what is seen in Diabetes Centre real-world practice.

References:

1. The Diabetes Control and Complications Trial Research Group, Nathan DM, Genuth S, et al. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin dependent diabetes mellitus. *New England Journal of Medicine*. 1993;329:977-986.
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4. Writing Group for the DCCT/EDIC Research Group, Orchard TJ, Nathan DM, et al. Association between 7 years of intensive treatment of type 1 diabetes and long-term mortality. *JAMA*. 2015;313:45-53.
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6. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). UK Prospective Diabetes Study (UKPDS) Group. *Lancet*. 1998;352:837-53.
7. Holman RR, Paul SK, Bethel MA, et al. 10-Year Follow-up of intensive glucose control in type 2 diabetes. *New Engl J Med*. 2008;359:1577-89.
8. Diabetes Canada Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2018;42(Suppl1):S1-S325

Please note:

1. References are provided in each section and are not sequential throughout the document.
2. Reference to any specific pharmaceutical products within this document does not imply endorsement.

SECTION 1

Medical Directive (Horizon Health Network)

Delegate Function (Vitalité Health Network)

Policy

Insulin Dose Adjustment as a Medical Directive (Horizon Health Network) Delegate Function (Vitalite Health Network)

Regional Health Authorities

You must follow the approved processes identified within your Regional Health Authority

(Insert your policy)

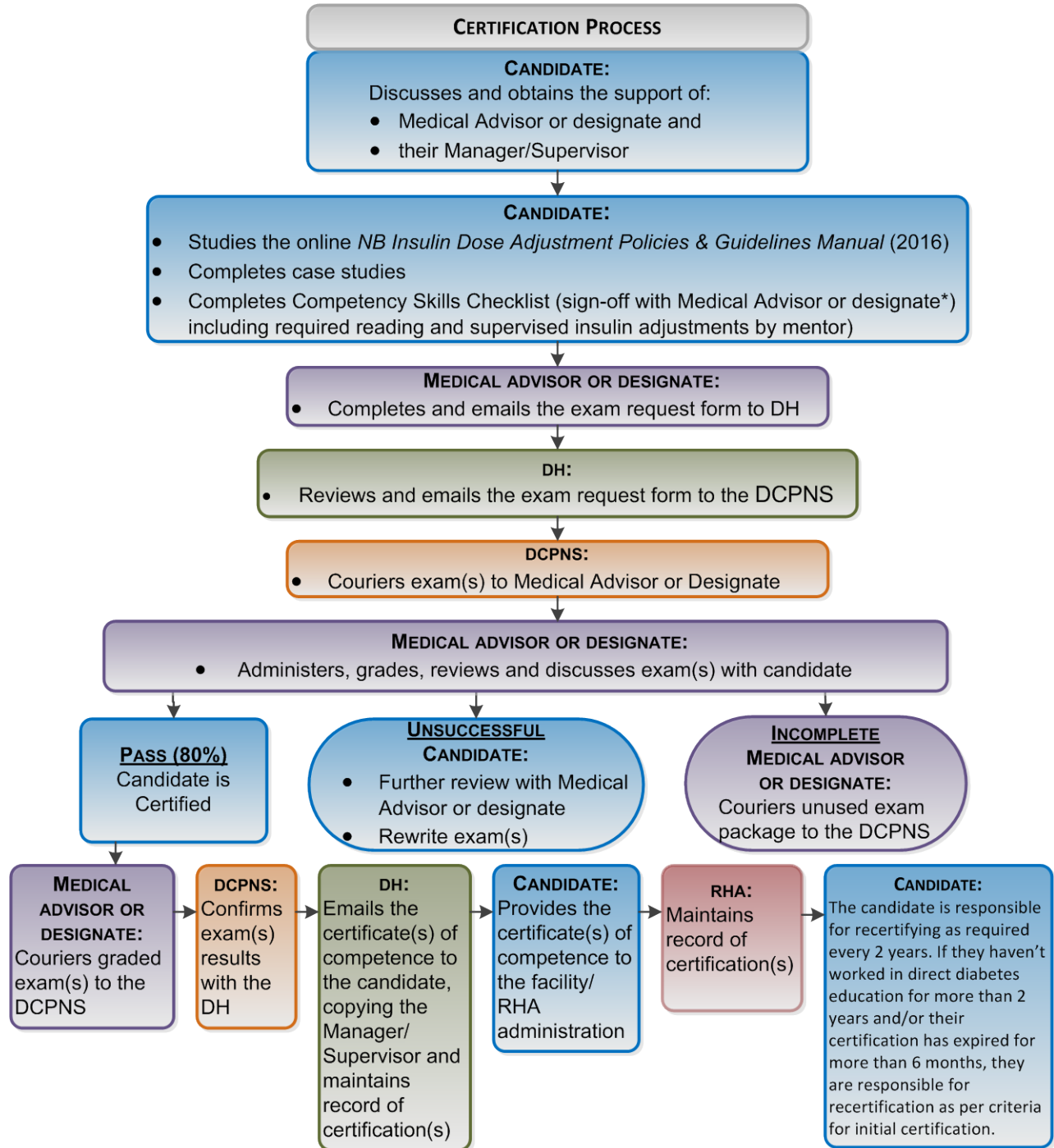
Criteria for Certification

- Must be a Certified Diabetes Educator*
- Must have a minimum of 800 hours of direct diabetes education and management within the last 3 years
- Must demonstrate how the insulin adjustment program is relevant for current work
- Must ensure the availability and support of a medical advisor (or authorized designate)
- Must ensure that they have support and approval from their manager or supervisor
- Must have studied all the course material and all case studies
- Must have completed the competency skills checklist
- Must have successfully completed the adult exam, prior to applying for any of the specialty exams

***Certified Diabetes Educator (CDE®).** Certification in diabetes education is provided by the Canadian Diabetes Educator Certification Board. This certification process is a designation to include all diabetes educators. Certification is a voluntary process that allows for identification of the health care professionals who are trained, experienced, and competent in diabetes education. In order to qualify for the CDE® examination, the diabetes educator must "...be registered with a regulatory body in Canada as a health professional and have obtained a minimum of 800 hours practice in diabetes education. The minimum of 800 hours of practice in diabetes education must be completed in a 3-year period immediately prior to the application deadline. All of the above must be attained while the individual is registered with a regulatory body in Canada as a health care professional." Therefore, in meeting the eligibility criteria for the CDE® process, the candidate has established direct clinical practice exposure and has broader diabetes knowledge in preparation for insulin dose adjustment. *Source: Canadian Diabetes Educator Certification Board (www.cdecb.ca). Accessed December 2015.*

*** Designate:** A certified diabetes educator that is also certified in insulin dose adjustment with demonstrated competency and confidence who is formally appointed by the physician with a specialty in diabetes to oversee the preparation and examination for insulin dose adjustment. To appoint a designate the medical advisor must complete the 'appointment of a designate' form.

Certification Flow Chart



* **Designate:** A certified diabetes educator that is also certified in insulin dose adjustment with demonstrated competency and confidence who is formally appointed by the physician with a specialty in diabetes to oversee the preparation and examination for insulin dose adjustment. To appoint a designate the medical advisor must complete the 'appointment of a designate' form.

Adult Initial Certification Competency Skills Checklist

Regional Health Authority (RHA): _____ Facility: _____

RN/PDt: _____

Medical Advisor (or Designate) Name/Initial: _____

The Medical Advisor (or designate) signs off topics as competency skills mastered.

Insulin dose adjustment (Adults)	Date & Signature (Medical Advisor/Designate)	Comments
Discusses policies and guidelines of insulin dose adjustment		
Obtains written/verbal physician directive for insulin dose adjustment		
Describes time action of insulin products		
Describes various insulin regimens for adults with type 1 & type 2 diabetes		
Identifies targets for glycemic control		
Describes potential risks of insulin dose adjustment		
Identifies variables that influence glycemic control, including frailty		
Correctly assesses SMBG records		
Discusses concepts of combination therapy		
Adjusts insulin correctly based on patterns of high blood glucose (hyperglycemia)		
Describes appropriate use of insulin with non-insulin therapies (including cautions and limitations)		
Adjusts insulin correctly for patterns of low blood glucose (hypoglycemia)		
Describes concepts of supplemental dose adjustment: <ul style="list-style-type: none"> • Compensatory • Anticipatory 		
Constructs a variable insulin dose algorithm		

Competency Skills Checklist (cont)

Insulin dose adjustment (Adults)	Date & Signature (Medical Advisor/ Designate)	Comments
Discusses concepts of intensive insulin therapy		
Discusses concepts of an MDI (basal/bolus) regimen		
Calculates insulin-to-CHO ratios		
Adjusts insulin correctly for illness/DKA		
Adjusts insulin correctly for exercise		
Adjusts insulin correctly for travel		
Adjusts insulin correctly for shift work		
Ensures appropriate follow-up (phone, visit, etc.)		
Appropriately documents actions		
Has completed self-directed reading/learning		
Discussed/reviewed case studies		
Passed written exam (80%)		

Specialty Areas Initial Certification Competency Skills Checklist

Regional Health Authority (RHA): _____ Facility: _____

RN/PDt: _____

Medical Advisor (or Designate) Name/Initial: _____

The Medical Advisor (or designate) signs off topics as competency skills mastered.

Insulin dose adjustment (specialty areas)	Date & Signature (Medical Advisor/ Designate)	Comments
Adjusts insulin correctly for pregnancy		
Adjusts insulin correctly for children & adolescents		
Adjusts insulin correctly for pump therapy		
Ensures appropriate follow-up (phone, visit, etc.)		
Appropriately documents actions		
Has completed self-directed reading/ learning		
Discussed/reviewed case studies		
Passed written exam (80%)		

Criteria for Recertification

Recertification is required every two years.

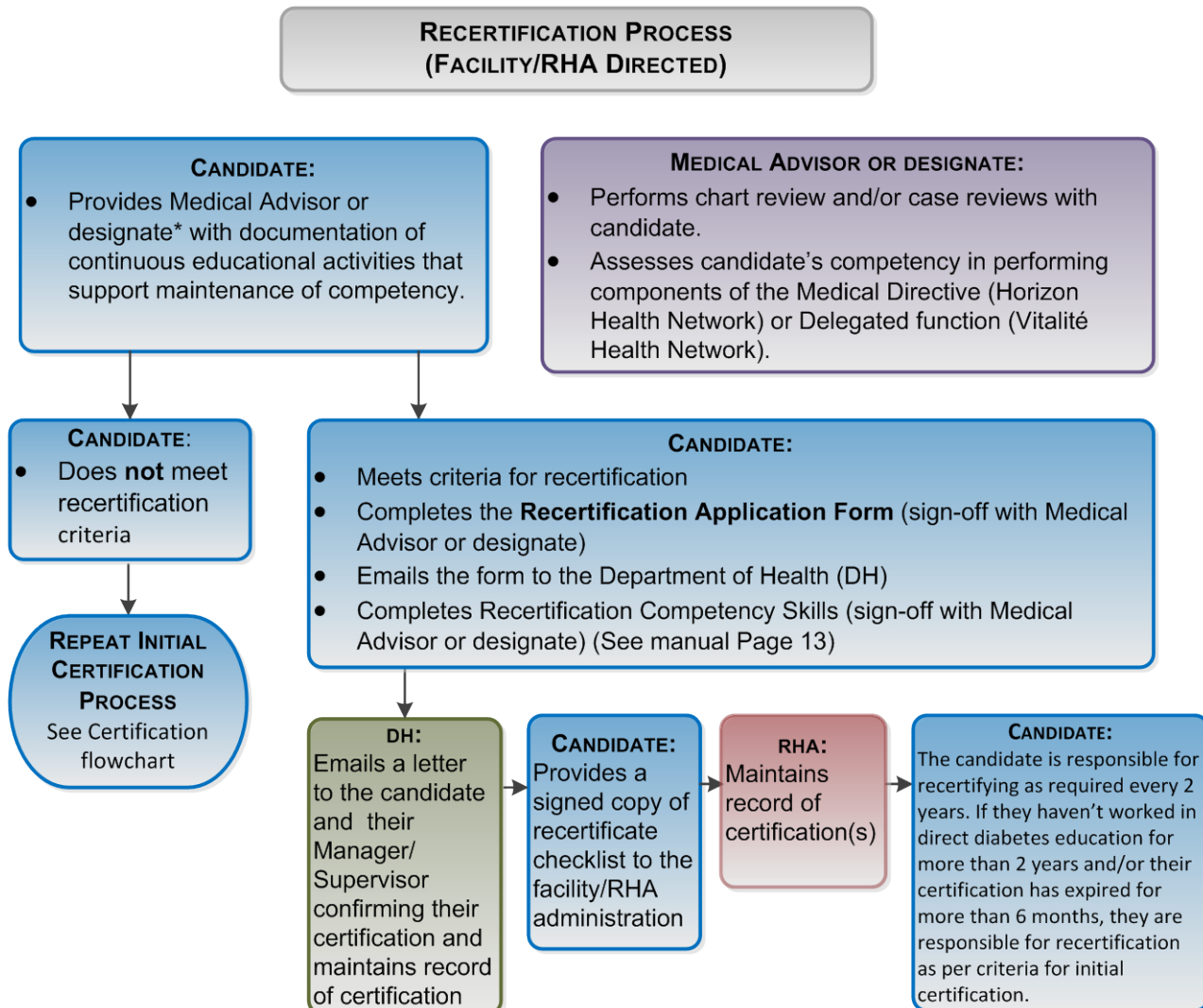
Recertification is the responsibility of the candidate and the RHA.

- Must be a Certified Diabetes Educator (attach a copy of the certificate to the application)
- Documented evidence of ongoing clinical work involving insulin adjustment.
- Demonstrated competency to perform components of the Medical Directive (Horizon Health Network) or Delegated Function (Vitalité Health Network).
- Documented evidence of attendance to workshops, conferences, journal clubs, etc. that support maintenance of competency.

Note: If diabetes educators haven't worked in direct diabetes education for more than two year and/or their certification has expired for more than six months, they are responsible for recertification as per criteria for initial certification every two years.

* **Designate:** *A certified diabetes educator that is also certified in insulin dose adjustment with demonstrated competency and confidence who is formally appointed by the physician with a specialty in diabetes to oversee the preparation and examination for insulin dose adjustment. To appoint a designate the medical advisor must complete the 'appointment of a designate' form.*

Recertification Flow Chart Criteria for Recertification in Insulin Adjustment



* **Designate:** A certified diabetes educator that is also certified in insulin dose adjustment with demonstrated competency and confidence who is formally appointed by the physician with a specialty in diabetes to oversee the preparation and examination for insulin dose adjustment. To appoint a designate the medical advisor must complete the 'appointment of a designate' form.

Recertification Competency Skills Checklist

Adult and/or Specialty Areas

The use of this form is optional. A site-specific form developed by the facility or RHA may be preferred.

Regional Health Authority RHA: _____ Facility: _____

RN/PDt: _____

Medical Advisor (or Designate) Name/Initial: _____

Date of Initial Certification: _____ Date of Recertification: _____

Criteria for Recertification	Date & Signature (Medical Advisor/Designate)	
	Insulin Adjustment for Adults	Specialty Areas <input type="checkbox"/> Pregnancy <input type="checkbox"/> Children & Adolescents <input type="checkbox"/> Pump Therapy
Candidate continues to meet all requirements of skills checklist as for Initial Certification in Insulin Dose Adjustment.*		
Candidate has provided documentation of continuous educational activities that support maintenance of competency.		
Chart reviews and/or case study reviews provide evidence of candidate's ongoing competency in the Medical Directive (Horizon Health Network) or a Delegated Function (Vitalité Health Network) for Insulin Dose Adjustment.		

* For a complete list of required competencies see **Adult Initial Certification Competency Skills Checklist and/or Specialty Areas Initial Certification Competency Skills Checklist** pages 13 and 15 respectively.

General Guidelines and Recommendations

Please check with your local zone and RHA policy

- 1a. For initiation of insulin, referring physicians must indicate if the diabetes educator certified in insulin dose adjustment is to assist with insulin dose adjustment.
 - 1.1 The referring physician must provide orders specifying type, time, and starting dose of insulin and authorization to make insulin dose adjustments. (*See sample Insulin Start Order Form; Section 5 - Documentation Forms, page 181.*)
- 1b. For re-referred or routine follow-up patients, insulin dose adjustment advice/guidance will be provided by the diabetes educator certified in insulin dose adjustment, unless otherwise specified by the referring physician.
- 1c. If diabetes educators are not to adjust insulin, the referring physician maintains responsibility for all changes in therapy.
2. Goals for blood glucose (BG) target range will comply with the current Canadian Diabetes Association (CDA) *Clinical Practice Guidelines* and will be individualized for each client.
3. Insulin adjustments will be made to optimize BG control and will be made on the basis of documented self-monitoring of blood glucose (SMBG) results and reported episodes of hypoglycemia and/or hyperglycemia following guidelines outlined in the *DCPNS Insulin Dose Adjustment Policies and Guidelines Manual, 2016*.
4. Initially, insulin will be adjusted on the basis of preprandial glucose results. However, when intensive insulin supplementation is desired and/or rapid-acting/short-acting insulin is used, insulin may be better adjusted according to both pre and postprandial BG results.
5. The diabetes educator and referring physician will communicate as needed to ensure the client is receiving optimal insulin doses.
6. If the diabetes educator feels that regimen changes are indicated, such as number of injections or type of insulin, this will be done in collaboration with the referring physician and client.
7. Insulin dose adjustments and follow-up plan will be documented on the client's chart and forwarded to the referring physician (according to individual clinic practice).
8. The diabetes educator will consult with the referring physician in the following situations:
 - Difficult or complex circumstances (as perceived by the diabetes educator).
 - If the client possibly requires a change in insulin type or regimen.
 - If the client's glycemic control is not improving despite adjustments to insulin or other components of the treatment plan.

Selection of Clients for Insulin Dose Adjustment

All clients * using insulin who are willing and able will be taught insulin dose adjustment.

Where possible, these individuals should also meet the following criteria:

- Have a referral to the Diabetes Centre authorizing insulin dose adjustment.
- Demonstrate the ability to perform regular, accurate self-monitoring of blood glucose (SMBG) and to record results.
- Demonstrate an interest in and ability to understand insulin dose adjustment.
- Have had and/or are willing to have a nutritional assessment and instruction with the diabetes educator (dietitian), including an introduction to or review of carbohydrate (CHO) counting.
- Willing to share and review SMGB results, and evaluates dose changes (by office visit, telephone, fax, or e-mail).

*If a client does not demonstrate the potential for, or interest in, safe dose adjustment (e.g., alcohol/substance abuse), the diabetes educator does have the right to refuse insulin dose adjustment and refer the client back to the referring physician to assume responsibility for insulin dosing.

* Client refers to the person with diabetes requiring insulin. The person taught may be a parent/guardian, spouse/partner, or responsible caregiver in certain circumstances.

Adult Insulin Dose Adjustment Guidelines

Learning Objectives

When specialty areas criteria for certification in insulin dose adjustment has been met, the diabetes educator (nurse or dietitian) will be able to:

- Describe the time action of the available insulin products.
- Describe the different insulin regimens for adults with type 1 and type 2 diabetes.
- Discuss concepts of combination therapy.
- Describe the potential risks of insulin dose adjustment.
- Identify variables influencing glycemic control that must be assessed before insulin dose adjustment is performed.
- Define dawn phenomenon.
- Discuss indications, methods, and rationale for insulin dose adjustment based on patterns of high and low BG results.
- Discuss indications, methods, and rationale for supplemental dose adjustment.
- Construct an algorithm and describe its use in making compensatory insulin dose adjustments.
- Define intensive therapy and describe key components of intensive regimens.
- Describe important points to consider when switching a client to an intensive (multiple daily injections or basal/bolus dose) regimen.
- Calculate insulin-to-CHO ratio and use this method to determine anticipatory insulin dose adjustments.
- Discuss indications, methods, and rationale for insulin dose adjustment for the following:
 - Illness and prevention/treatment of DKA
 - Physical activity/exercise
 - Travel
 - Shift work

Specialty Areas

(Prerequisite: Adult Insulin Dose Adjustment Certification)

Learning Objectives

When **specialty areas** criteria for certification in insulin dose adjustment has been met, the certified diabetes educator will be able to:

- Discuss concepts of insulin dose adjustment for pregnancy.
- Discuss concepts of insulin dose adjustment for children/adolescents.
- Discuss indications, methods, and rationale for insulin dose adjustment for pump therapy:
 - Adults
 - Children/adolescents

SECTION 2

Adult Insulin Dose Adjustment Guidelines

Insulin Therapy

Insulin therapy is essential for the management of type 1 diabetes and may be needed by clients with type 2 diabetes. The effective use of insulin to obtain the best metabolic control requires an understanding of the duration of action of the various types of insulin and the relationship of blood glucose (BG) levels to exercise/physical activity, food intake, intercurrent illness, and certain medications. It also requires learning to adjust insulin dosages to achieve the individualized target goals established between the client and diabetes health care team (HCT) as per the *Canadian Diabetes Association Clinical Practice Guidelines*.¹ Insulin requirements are different for each person and can change with time.

It is the physician's responsibility to determine the initial insulin dose and regimen.

Insulin therapy is ideally started on an outpatient basis through the Diabetes Centre (DC) and involving the diabetes HCT. Education for the person starting insulin therapy should include insulin administration, time action profiles, self-monitoring of blood glucose (SMBG), interpretation of results, treatment of hypoglycemia, meal planning, CHO sources, problem solving, dose adjustments, activity, and sick day management. Active involvement of the client in self-care management with support and follow-up by the diabetes HCT are important components in assisting clients to achieve optimal diabetes management. Consistent meal/snack and physical activity routines are very important during insulin initiation and insulin adjustment (titration) to achieve desired glycemic control.

Before starting insulin therapy, determine if the person has an extended health insurance plan to cover the cost of insulin and supplies as well as BG monitoring strips for additional BG testing. Check periodically to see if newer insulin analogues are included in the Provincial Formulary.

Type 1 – Adult – Key Points

- Insulin therapy is required for the treatment of type 1 diabetes.¹ Clients with type 1 diabetes are initiated on insulin therapy immediately at diagnosis.¹ The absolute insulin deficiency of established type 1 diabetes can only be treated effectively with basal-bolus injection therapy (three or more injections of prandial insulin, and one to two injections of basal insulin) or continuous subcutaneous insulin infusion (CSII).¹
 - For most Clients with type 1 diabetes, premixed insulin preparations are not suitable¹; however, some Clients, depending on the circumstance (age, frailty, social supports), may achieve their treatment goals with a premixed regimen.²
- The role of non-insulin therapies (oral or injectables) is limited for most people with type 1 diabetes.¹
- Insulin regimens should be individualized and tailored to the individual's treatment goals, lifestyle, diet, age, general health, motivation, hypoglycemia awareness status, financial/social aspects, and ability for self-management.¹
- Basal insulin refers to long- or intermediate acting insulin (control of blood glucose in the fasting state and between meals), given once or twice daily. Long acting insulins have variable duration, 24- to 42-hours. See Table 2.2, page 30.
- Biosimilar insulin, while similar is not identical to its reference insulin, but has been shown to have similar properties, efficacy and safety.¹ (These types of insulins will increase in the future. They have the same amino acid sequence but may have different molecular characteristics and may work slightly differently).
- New concentrated insulin preparations are available in basal and bolus formats. Pharmacological properties may change, so check carefully before initiating/adjusting. Some longer acting insulins have an extended, flat release with a longer duration of action, and may require a larger dose.¹ See Table 2.2, page 30.

- Bolus insulin refers to rapid or short-acting insulin given at meals to control the glycemic rise at meals and to correct hyperglycemia.¹ See Table 2.2, page 30.
 - The time of the preprandial injection varies by insulin type, some 0-15 minutes before the start of the meal, others 30-45 minutes, and for some at the start of the meal or up to 20 minutes after the meal, although better post prandial control is achieved with preprandial administration.¹
- Rapid-acting insulin analogues, in combination with adequate basal insulin, should be considered over regular insulin to improve A1C while minimizing the occurrence of hypoglycemia and to achieve postprandial glucose targets.¹
- As an alternative to intermediate-acting insulin, long-acting insulin analogues may be considered as the basal insulin to reduce the risk of hypoglycemia including nocturnal hypoglycemia.¹
- The total daily insulin requirements in adults with Type 1 diabetes are usually 0.3³-0.4² to 1.0 units/kg of body weight/day¹⁻³, given in divided doses; with 0.5 units/kg as the typical starting dose
- Insulin requirements will be lower (0.2 to 0.6 units/kg of body weight/day) during the honeymoon phase. This is the period of remission early in the course of the disease that is characterized by residual endogenous insulin secretion and may last from weeks to months.²
- Initiation and titration of insulin is guided by routine/regular meal/snack times, consistency in CHO (sources and amounts) and usual physical activity/exercise patterns as well as frequent self-monitoring of blood glucose (SMBG). Education focused on matching premeal insulin to CHO intake, premeal BG, and anticipated activity should be provided⁴
- Insulin requirements will fluctuate during illness and are often higher in the presence of intercurrent illness or other metabolic instability. This requires careful monitoring. *See Illness and Prevention/Treatment of DKA section, page 76.*
- Knowledge of the acute effects of exercise is essential. Low to moderate intensity exercise lowers BG levels during and after the activity.¹ SMBG before, during, and after exercise is important to establish response patterns.¹
- All Clients with type 1 diabetes initiating insulin therapy should be counseled about:
 - The risk, prevention, and treatment of hypoglycemia.¹ - Avoidance of nocturnal hypoglycemia.
 - The risk, prevention, and treatment of DKA.
 - Expected changes in insulin doses (titration).
 - The importance of site rotation, and the impact on absorption and insulin action.
- Continuous glucose monitoring (CGM —real-time [rt] or intermittently scanned [is]—flash glucose monitoring), may be useful to identify periods of glucose variability. Sensor augmented therapy, used on an ongoing basis is useful in day-to-day management.

Recommended Starting Doses (Type 1 Diabetes)

- The typical starting dose is 0.5 units/kg.
 - Approximately 40-60% of the total daily dose generally given for basal needs (to cover glycemia in the periods between meals and overnight), and should be a long acting insulin.
 - The remainder is given as bolus insulin to cover meal times (three injections per day). This is a starting point, and should be adjusted accordingly. Bolus doses will be matched to carbohydrate intake, premeal BG values, and anticipated physical activity.⁴

Type 2 – Adult – Key Points

- Due to the progressive nature of type 2 diabetes, most people will eventually require insulin therapy in addition to non-insulin therapy (oral or injectables) to compensate for the diminishing supply of endogenous insulin.³
- Clients should be assessed for ability/readiness to initiate and self-adjust insulin; and supported as needed in the presence of psychological insulin resistance.⁵
- Choice of therapy should include considerations of efficacy and key patient factors:
 - Presence/risk for comorbidities,
 - Hypoglycemia risk,
 - Effect on body weight,
 - Side effects,
 - Affordability,
 - Ease, and
 - Patient preference.^{4,6}
- Insulin requirements vary considerably and may range from as little as 5 to 10 units/day to more than 100 units/day. This is because of interpatient variability of insulin deficiency and insulin resistance.
- All Clients with type 2 diabetes initiating insulin therapy should be counseled about:
 - The recognition, treatment and prevention of hypoglycemia.¹
 - Avoidance of nocturnal hypoglycemia.
 - Sick day management
 - Expected changes in insulin dose (titration) and frequency of injections (regimen).
 - The importance of site rotation, and the impact on absorption and insulin action.
- In type 2 diabetes, treatment includes long-acting or intermediate acting once or twice daily for basal glycemic control. Long-acting insulin analogues may be considered in clients with type 2 diabetes who have a history of nocturnal hypoglycemia using human insulin.
- Regardless of the insulin regimen chosen, the dose should be adjusted to achieve glycemic targets.¹
 - For many people with type 2 diabetes, (e.g., Clients with relaxed targets, low rates of hypoglycemia, and prominent insulin resistance, as well as those with cost concerns), human insulin (NPH and Regular) may be the appropriate choice of therapy, and clinicians should be familiar with their use.²
 - Premixed insulin (e.g., 30/70, 50/50, Mix 25, etc.) can be helpful for people who have trouble drawing up insulin out of two bottles and reading the correct directions and dosages.¹ Premixed insulin products are available pens.⁴ It is also useful for those who have poor eyesight or dexterity and is convenient for people whose diabetes has been stabilized on this combination.⁷
- Initiation and advancement of insulin is guided by routine/regular meal/snack times, consistency in carbohydrate (CHO) (sources and amounts), and usual physical activity/exercise patterns as well as frequent SMBG.
- Concentrated insulins should be considered for those requiring large doses of insulin to reduce the volume of insulin administered. The pen will deliver the correct amount of insulin in *less volume*.
- Testing will be more frequent during insulin initiation to assess the patterns and how the insulin is

working. Advancing the insulin regimen is based on frequent SMBG and the appropriate reaction (increasing the dose, or adding additional injections).

- Continuous glucose monitoring (CGM—real-time [rt] or intermittently scanned [is]—flash glucose monitoring [FGM]), as part of a structured education program/approach to facilitate behavior change, may be useful to identify and help to make treatment decisions during periods of glucose variability.¹ Prandial insulin should be considered when the total daily dose (TDD) of basal insulin is greater than 0.5 units /kg BW.⁶ Cover the largest meal first and additional meal coverage as needed.⁶

Recommended Starting Doses (Type 2 Diabetes)

The starting dose is estimated based on body weight and degree of hyperglycemia, with titration over days and weeks as needed.²

Basal Insulin:

- If using intermediate-acting or long acting insulin, consider a starting dose 0.1 to 0.2 units/kg of body weight^{2,6} or if lean, 10 units¹, bedtime¹. The bedtime (hs) starting dose is intended to target the fasting plasma glucose (FPG).
 - If using a long-acting insulin analogue that is 24 to 42 hours duration, other times of the day can be used for this initial insulin injection—morning or supper may be a better time if there is fear of nocturnal hypoglycemia.^{1,2}

Bolus/Prandial (meal time) Insulin:

- When starting bolus insulin, it should be added as one injection at the largest meal, and additional mealtime injections at three-month intervals.¹
 - A recommended starting dose of 10% of the basal dose² or 2 to 4 units¹, at the largest meal.

Premixed Insulin:

- If using a premixed insulin, consider a dose of 5 to 10 units administered once or twice daily pre-breakfast and/or pre-supper.¹ Alternatively, based on general clinical experience, a starting dose of 0.1 to 0.2 units/kg of body weight can also be used to calculate pre-breakfast and/or pre-supper doses.

Note: Routine/regular follow-up should be planned/scheduled to assess impact on blood glucose results, patient acceptance of the regimen/dosing, and the need for titration of the basal rate.

Adding Insulin to Non-Insulin Therapies (See Page 44 for Combination Therapy)

- When insulin is added to non-insulin therapy, a single injection of basal insulin (intermediate or long-acting insulin) may be used.
 - Since basal insulins (intermediate- and long-acting) do not control postprandial glucose levels, clients should be instructed to keep taking any other non-insulin therapies as recommended by the ordering physician. See Section 4, Table 4.4, page 176.
 - This approach may result in better glycemic control with a smaller dose of insulin and may induce less weight gain and fewer hypoglycemic episodes than that seen when non-insulin therapies are stopped and insulin is used alone.^{1,2}
 - If daytime hypoglycemia occurs, the non-insulin therapy (secretagogues) may need to be reduced or discontinued or the insulin dose reduced.
- The addition of bedtime insulin to metformin may lead to less weight gain.¹

Metformin, GLP-1 agonists -SGL T2 inhibitors can be continued unless contraindicated.
Cost/affordability, and regime complexity should be considered.

Recommended Starting Doses

- If using a long-acting insulin analogue, consider a starting dose of 10 units once daily at bedtime.

Table 2.1 Recommended Targets for Glycemic Control*

	Glycated Hemoglobin (A1C)	Fasting Plasma Glucose (FPG) or Preprandial PG	2-hour Postprandial PG
Types 1 & 2 Diabetes	less than or equal to 7.0 % (range less than or equal to 6.5-8.5%)	4.0 – 7.0 mmol/L	5.0 – 10.0 mmol/L (5.0 – 8.0 mmol/L, if A1C targets less than or equal to 7% not being met)

*Treatment goals and strategies must be tailored to the individual with diabetes, with consideration given to individual risk factors¹. Glycemic targets for children 12 years of age and under and pregnant women differ from these targets¹. *See Section 3 – Specialty Areas for further details.* Glycemic targets also differ for the frail elderly.⁸

Table 2.2: Types of Insulin Available in Canada

TYPE TYPES OF INSULIN S OF INSULIN			
Insulin Type (trade name)	Onset	Peak	Duration
Prandial (bolus) Insulins			
Rapid-acting (RA) insulin analogues (clear) Insulin aspart (NovoRapid®) Insulin glulisine (Apidra®) Insulin lispro (Humalog®) U-100,U200 Faster-acting insulina spart(Fiasp®)	9 to 20 minutes 10 to 15 minutes 10 to 15 minutes 4 minutes	1 to 1.5 hours 1 to 1.5 hours 1 to 2.0 hours 0.5 to 1.5 hours	3 to 50 hours 3.5 to 5 hours 3. to 4.75 hours 3 to 5 hours
Short-acting (SA) insulin (clear) Insulin regular [Humulin® R, Novolin® ge Toronto] Insulin regular [Entuzity (U-500)]	30 minutes 15 minutes	2 to 3 hours 4 to 8 hours	6.5 hours 17-24 hours
Basal Insulins			
Intermediate-acting (IA) insulin (cloudy) Humulin® N Novolin® ge NPH	1 to 3 hour	5 to 8 hours	up to 18 hours* * Intermediate-acting insulin duration of up to 24 hours in young children ⁹ .
Long-acting (LA) insulin analogues (clear) Insulin detemir U-100(Levemir®) Insulin glargine U-100(Lantus®) Insulin glargine U-300(Toujeo TM) soloStar® Insulin glargine biosimilar U-100 (Basalgar®) Insulin degludec U-100, U-200(Tresiba®)	90 minutes	Not Applicable	U-100 Detemir, 16 - 24 hours; U-100 Glargine, 24 hours; U-300 Glargine, greater than 30 hours; Degludec, 42 hours
Premixed Insulins			
Premixed regular (PMR) insulin – NPH (cloudy) Humulin® 30/70 Novolin® ge 30/70, 40/60, 50/50	A single vial or cartridge contains a fixed ratio of insulin (% of rapid-acting or short-acting insulin to % of intermediate-acting insulin).		
Premixed (PMA) insulin analogues (cloudy) Biphasic insulin aspart (NovoMix®30) Insulin lispro/lispro protamine (Humalog® Mix 25 and Mix 50)			

Note: Physicians and Nurse Practitioners should refer to the most current edition of *Compendium of Pharmaceuticals and Specialties* (Canadian Pharmacists Association; Ottawa, Ontario Canada) and product monographs for detailed information.

Adopted from: Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Can J Diabetes. 2013;37(suppl 1):S57. 2015 update, table 1 accessed from CDA website December 2015.

Table 2.3 Insulin Abbreviations Used Throughout the Guideline

Insulin Type (trade name)	Abbreviation
Prandial (bolus) Insulins	
Rapid-acting insulin analogues (clear) Insulin aspart (NovoRapid®) Insulin lispro (Humalog®), U-100, U-200 Insulin glulisine (Apidra®) Insulin lispro (Humalog® Kwikpen®) Faster-acting insulin aspart (Fiasp®)	RA FRA
Short-acting insulins (clear) Humulin® R Novolin® ge Toronto	SA
Basal Insulins	
Intermediate-acting insulins (cloudy) Humulin® N Novolin® ge NPH	IA
Long-acting insulin analogues (clear) Insulin detemir (Levemir®) Insulin glargine (Lantus®) Insulin glargine U-300 (Toujeo®) Insulin glargine biosimilar (Basalgar®) Insulin degludec U-100, U-200 (Tresiba®)	LA
Premixed Insulins	
Premixed regular insulins – NPH (cloudy) Humulin® 30/70 Novolin® ge 30/70, 40/60, 50/50	PMR
Premixed insulin analogues (cloudy) Biphasic insulin aspart (NovoMix®30) Insulin lispro/lispro protamine (Humalog®Mix25 and Mix50)	PMA

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1. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2018;42(Suppl1):S1-S325.
2. American Diabetes Association. Standards of Medical Care in Diabetes-2019. *Diabetes Care*. 2019;42(suppl 1):S90-102.
3. Diabetes Canada. *Building Competency in Diabetes Education: The Essentials 5th Edition*. Toronto, ON: Author; 2019.
4. American Diabetes Association. *Practical Insulin: A Handbook for Prescribing Providers, 4th Edition*. Alexandria, VA: Author; 2015.
5. Self-Adjustment of Insulin Resources. Diabetes Care Program of Nova Scotia. Website: <https://www.cdha.nshealth.ca/node/21399> Accessed January 2020.
6. AACE/ACE Consensus Statement. Consensus Statement by the American Association of Clinical Endocrinologists and American College of Endocrinology on the Comprehensive Type 2 Diabetes Management Algorithm—2019 Executive Summary. *Endocrine Practice*. 2019;25(1):69-100.
7. Insulin Basics. American Diabetes Association. Website: <https://www.diabetes.org/diabetes/medication-management/insulin-other-injectables/insulin-basics> Accessed January 2020.
8. Diabetes Guidelines for Frail Elderly Residents in or Awaiting Long-Term Care (LTC): Pocket Reference. Diabetes Care Program of Nova Scotia. Website: <https://www.cdha.nshealth.ca/system/files/sites/documents/diabetes-guidelines-frail-elderly-residents-or-awaiting-ltc-pocket-reference.pdf> Accessed January 2020.

Insulin Regimes

There are several insulin regimens currently in use. The starting dose and schedule of insulin administration is based on clinical assessment and the individual's meal times, exercise/physical activity, and work schedule. As much as possible, the individual's preferences should prevail in the choice of insulin regimen and delivery method.

- For Clients with type 1 diabetes, multiple daily injections (MDI) or basal/bolus regimens are required to best manage this type of diabetes.
- For Clients with type 2 diabetes, basal insulin (intermediate-acting or long acting insulin), is started once daily, usually at bedtime. (Note: the newer LA insulins [42-hour] are often initiated in the morning, but the time may vary depending on patient preference.) The basal dose is titrated up to normalize the fasting plasma glucose (FPG). Titration to the desired blood glucose can take a number of days/weeks depending on the fasting blood glucose, dose response and the type of insulin that is started). See page 55 for insulin adjustment/titration guidelines.
- Depending on how the diabetes advances, 2, 3, or more injections may be added accordingly to improve prandial values.

Most Clients will choose to use insulin pens for their injections (one pen per type of insulin), while others may choose to use a syringe to mix appropriate insulins (split mixed). For some, this practice of split mixed (two types of insulin in one syringe) will reduce the number of injections required at certain times of the day. For example, mixing the breakfast dose of rapid-acting or short-acting insulin with an intermediate-acting insulin in a single syringe would result in only one injection at breakfast.

Note: Long-acting insulin analogues and concentrated insulins cannot be mixed with any other insulin; and, concentrated insulins of greater than U-100 and are only available in pen devices.

The following provides an overview of the various insulin regimens, starting with four or five injections per day (as the regimen most used in Clients with type 1 diabetes) followed by examples of one, two, and three injections per day (used with variable success in the type 2 population). Indications for use, as well as advantages and disadvantages of each regimen are provided along with examples and time action curves.

Overview of Insulin Regimens

Four or Five (4 or 5) Injections a Day

Indications:

- All adults with type 1 diabetes.
- All Clients with type 2 diabetes trying to obtain better glucose control when non-insulin therapy has failed and less frequent injections do not result in improved control.

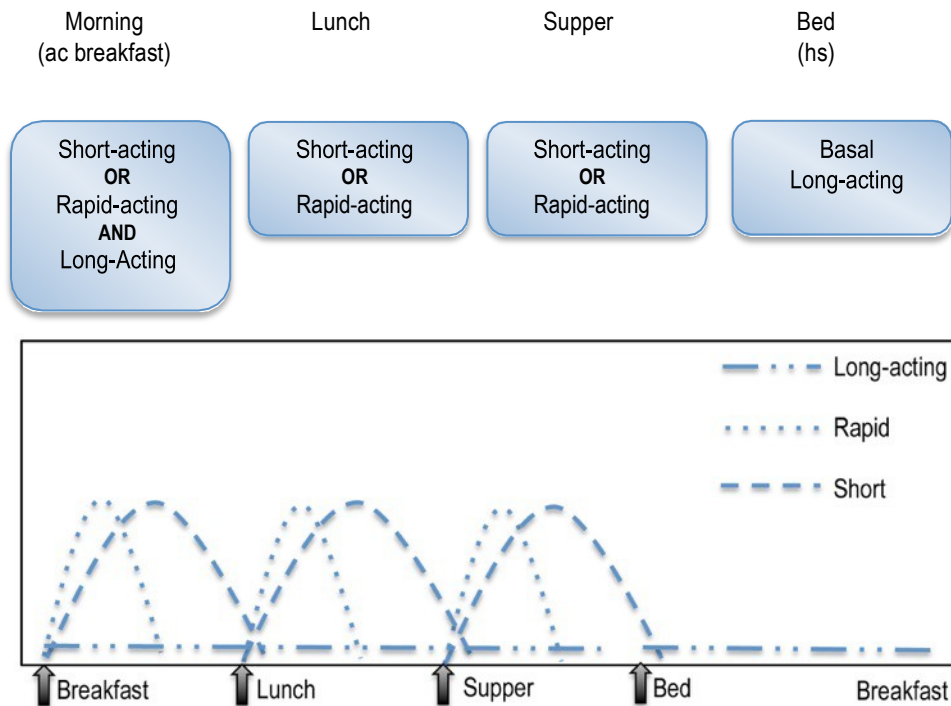
Advantages:

- Offers flexibility in meal size and timing.¹

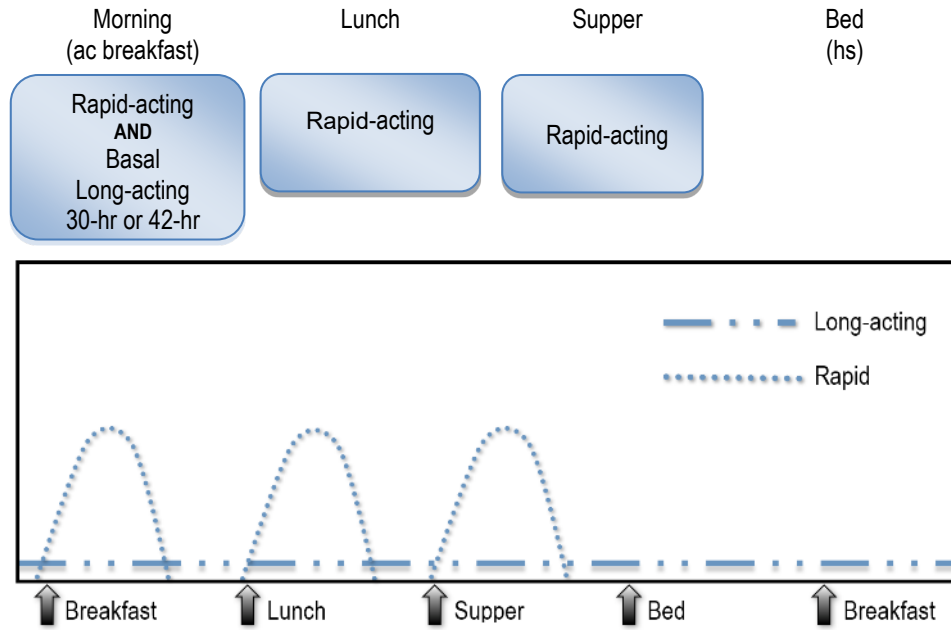
- Is easily understood by most clients because each period of the day has a defined insulin component.
- If using long-acting insulin analogue, it is easily titrated to address fasting hyperglycemia with minimal risk of nocturnal hypoglycemia.
- Long-acting 24- to 42-hour duration insulin given in the morning helps to reduce the risk of hypoglycemia.

Note: If a syringe is being used to mix insulins, remind the client that the long-acting insulin analogues and insulins that are not U100 cannot be mixed with any other insulins.

Example 1: Four to five injections per day

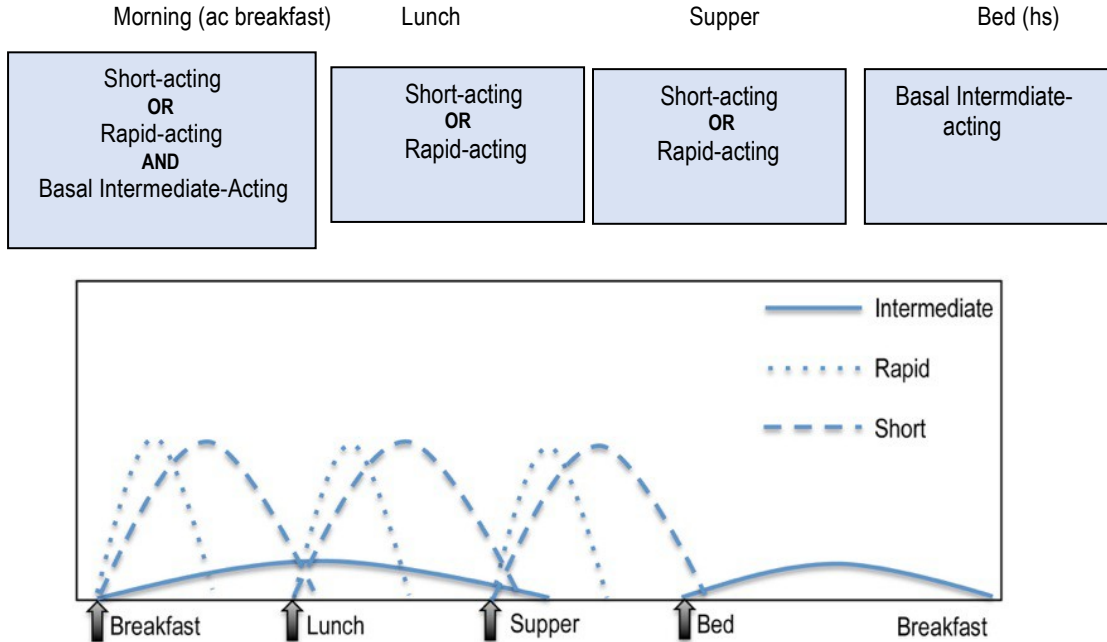


Example 2: Four to five injections per day (30-hr to 42-hr LA)

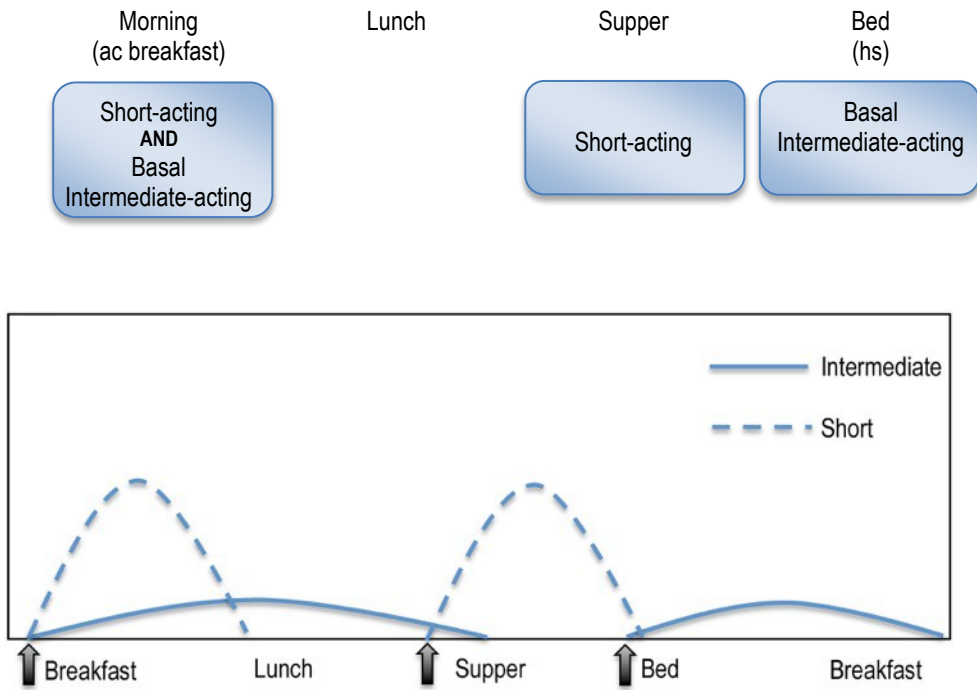


NOTE: LA 30-hr to 42-hr can be given once daily at any time of the day, but ideally at the same time each day.

Example 3: Four to Five Injections per day



Example 4: Four or Five injections per day



One (1) Injection a Day

Indications:

- Type 2 diabetes.
- Often in combination with non-insulin therapies.
- Not indicated for type 1 diabetes. May be effective for short periods of time during the honeymoon phase when residual insulin secretion is substantial, but is not recommended.

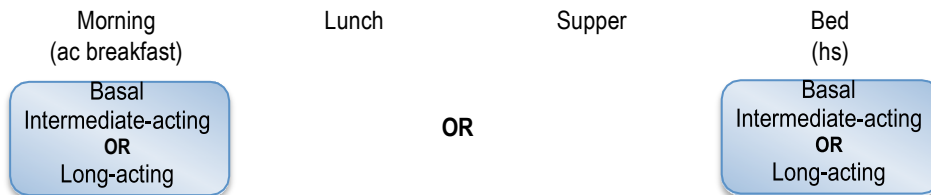
Advantages:

- Bedtime dosing may improve fasting BG control by suppressing nocturnal hepatic glucose production.

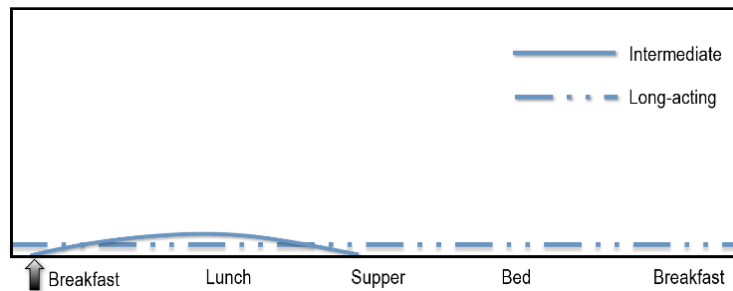
Disadvantages:

- Lack of flexibility dealing with before meal (prandial) or postprandial glucose.¹

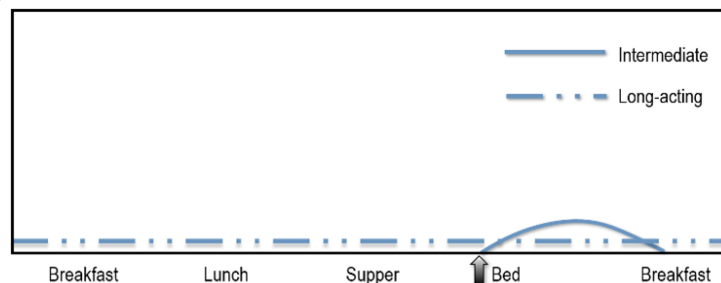
Examples:



Morning dose



Bed Dose



Two (2) Injections a Day

Indications

- Type 2 diabetes.
- For clients with type 2 diabetes who are treated with one or more non-insulin therapies.
- To address late afternoon and early evening hypoglycemia for clients on bedtime (hs) insulin.
- For clients with type 2 diabetes who are changing from a single large dose to two injections a day.
- Adding a short- or rapid-acting insulin to an insulin analogue.

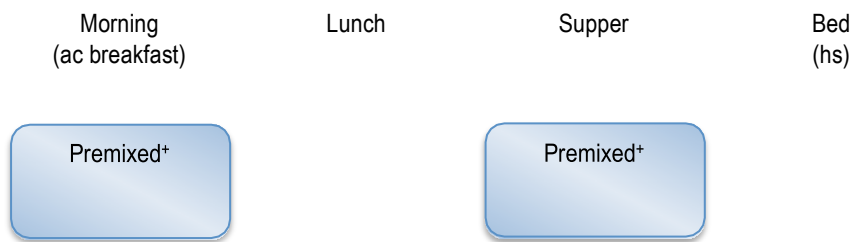
Advantages:

- Ability to try to gain better blood glucose control.
- Mealtime flexibility.

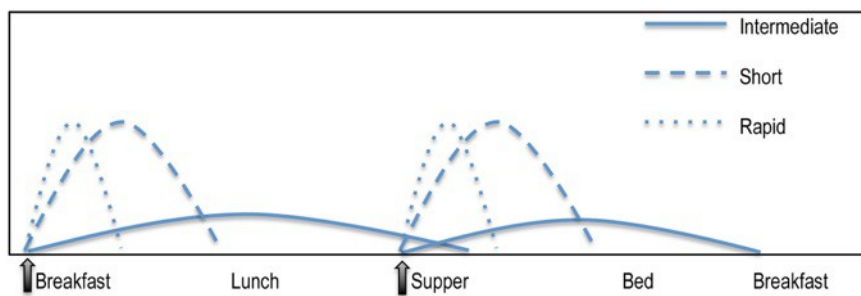
Disadvantages:

- Intermediate-acting insulin before supper may peak overnight causing nocturnal hypoglycemia and/or high fasting BG.¹
- Inability to cover specific mealtime excursions as demonstrated in examples 2 to 5.¹

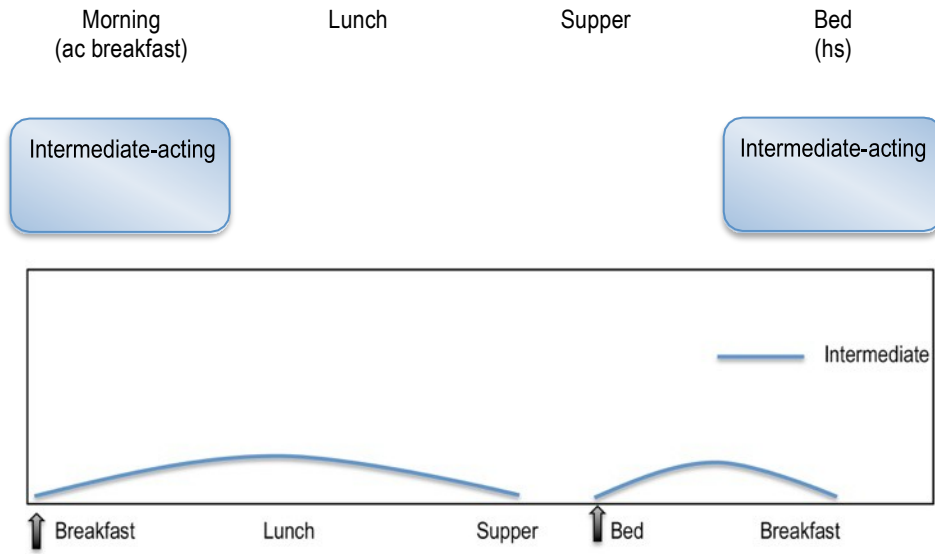
Example 1: Two injections per day



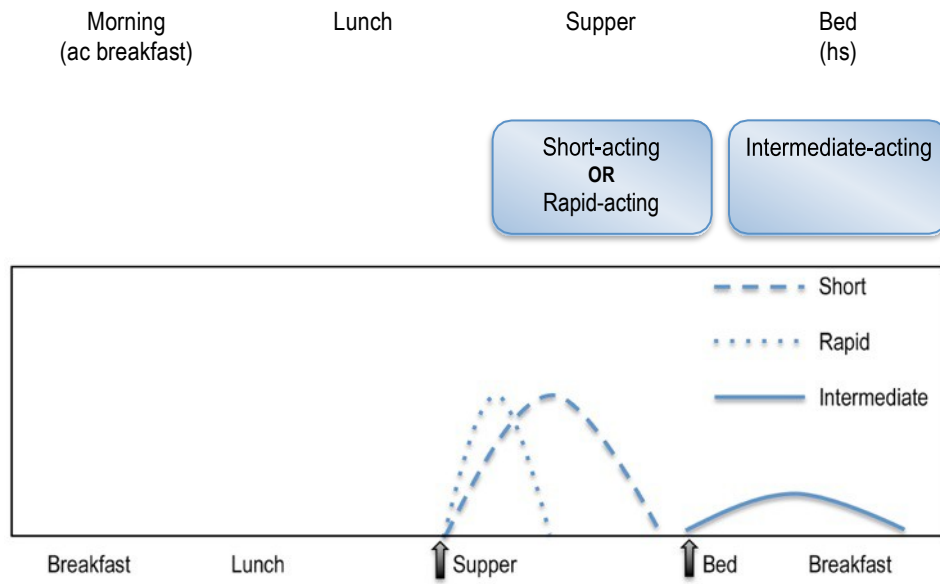
+ Premixed may also be when using a syringe and mixing rapid or short-acting with intermediate-acting in the morning and at supper.



Example 2: Two injections per day



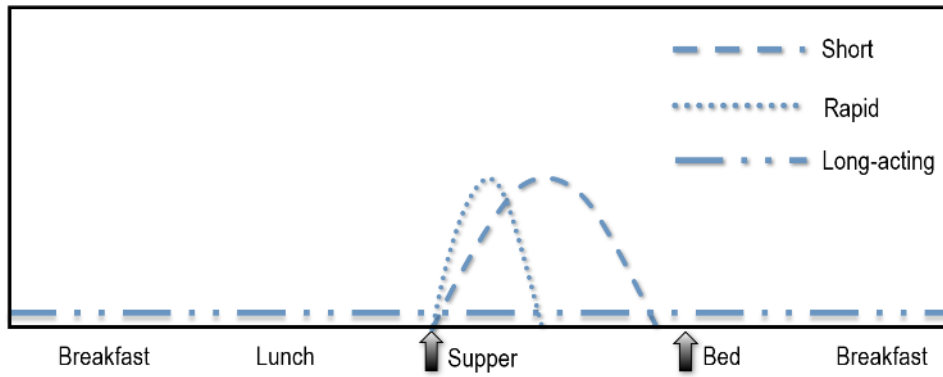
Example 3: Two injections per day



Example 4: Two injections per day

Morning (ac breakfast) Lunch Supper Bed (hs)

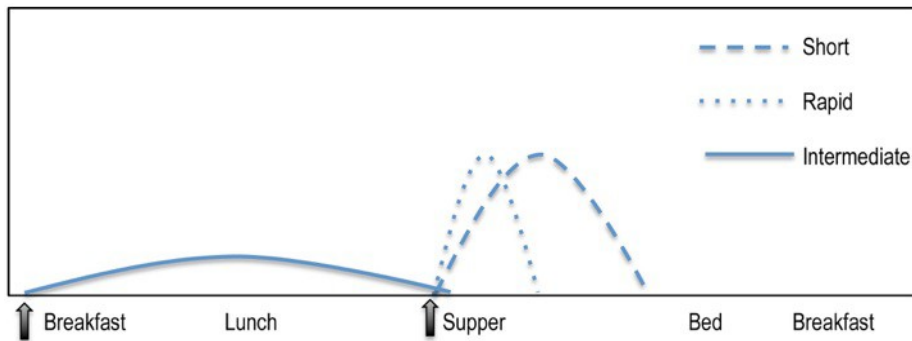
Short Acting or Rapid Acting Basal Long Acting



Example 5: Two injections per day

Morning (ac breakfast) Lunch Supper Bed (hs)

Intermediate-acting Short-acting OR Rapid-acting



Three (3) Injections a Day

Indications:

- Type 2 diabetes.
- Generally, it is not possible to achieve near-normal glycemic levels in type 1 diabetes with three injections a day.

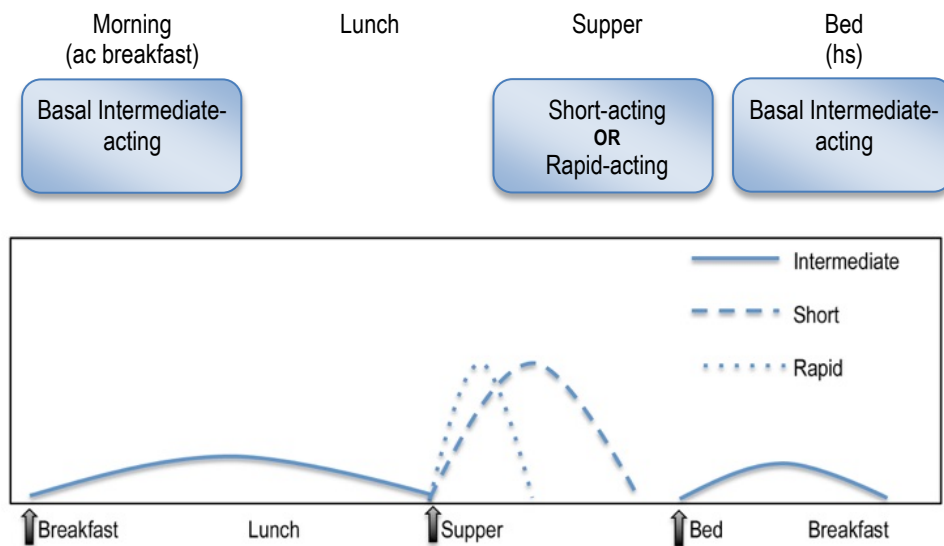
Advantages:

- Reduction in preprandial and postprandial hyperglycemia.
- Better glucose control overnight.¹

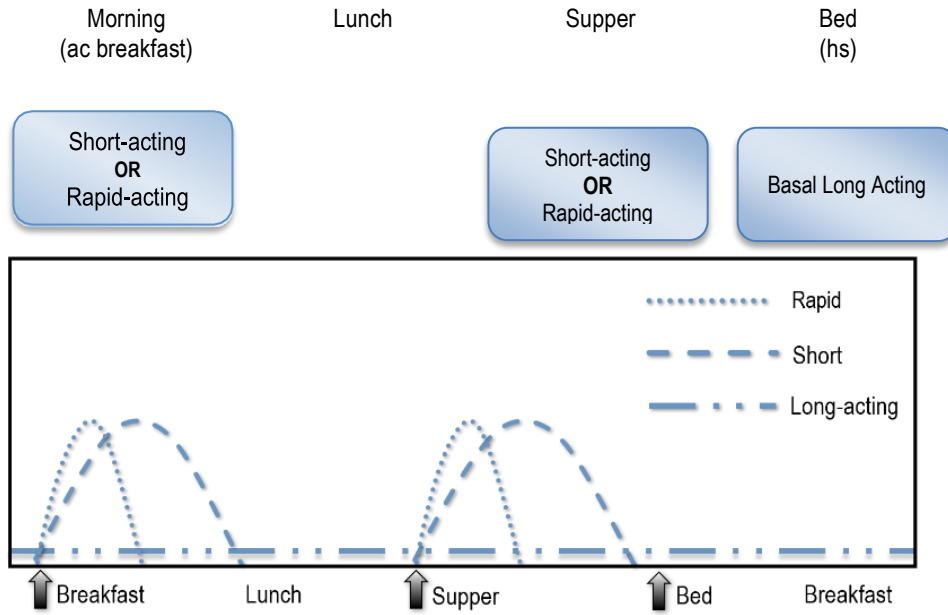
Disadvantages:

- If there is no insulin injected at noon then there is a lack of flexibility dealing with the effects of the noon meal, i.e., 2-hour pc lunch and ac supper.¹

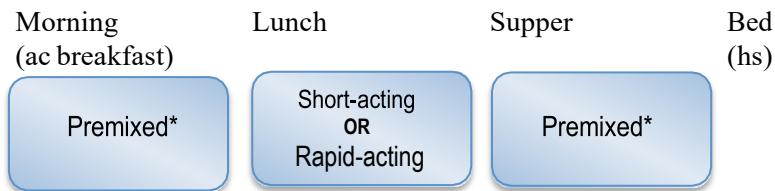
Example 1: Three injections per day



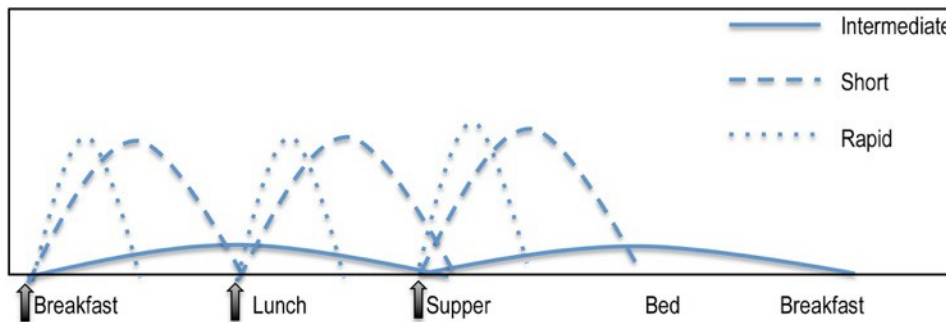
Example 2: Three injections per day



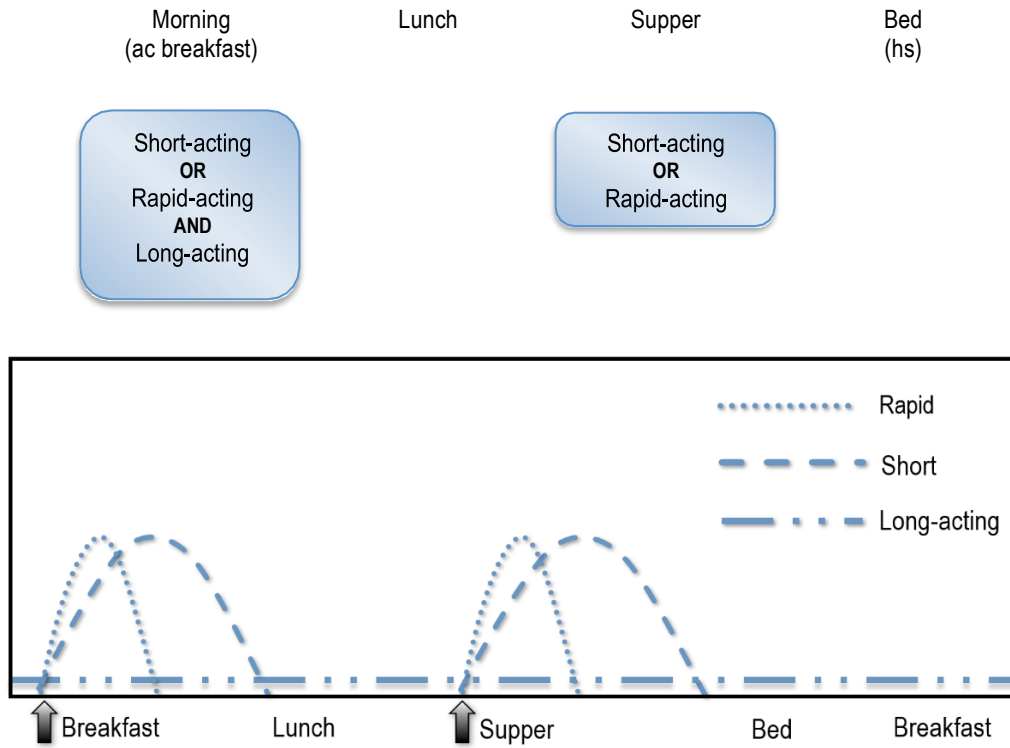
Example 3: Three injections per day



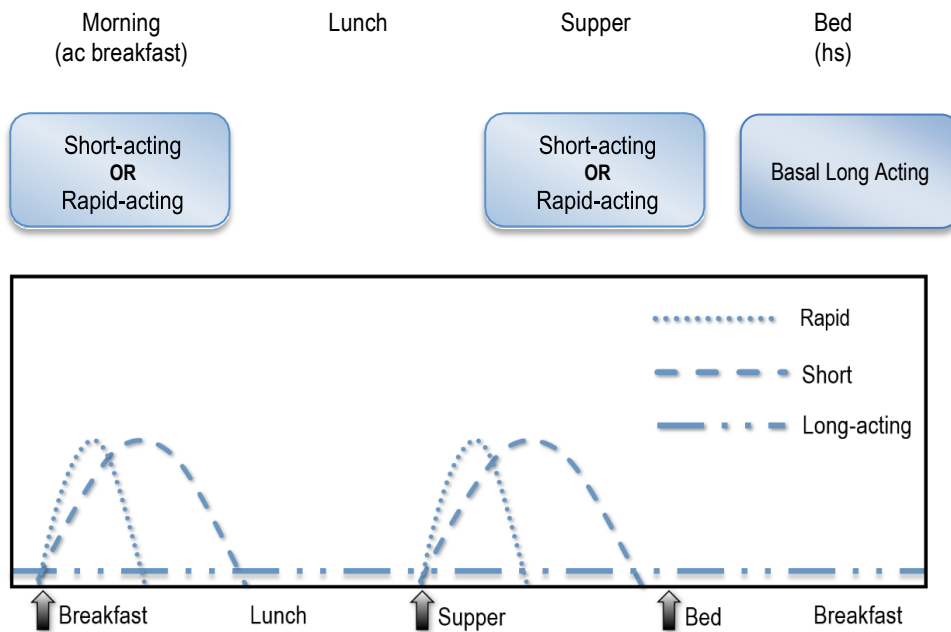
* Premixed may also be when using a syringe and mixing rapid- or short-acting with intermediate-acting in the morning and at supper.



Example 4: Three injections per day



Example 5: Three injections per day



Combination Therapy

Combination therapy involves the addition of insulin to non-insulin therapies, or non-insulin therapy to insulin for Clients with type 2 diabetes.

Key Points

- Medication choice should be based on drug-specific effects and patient factors.^{1,2} Considerations include avoidance of side effects, particularly hypoglycemia and weight gain, cost/affordability and patient preference.^{1,2}
- Medications with proven cardiovascular benefit may be of value in Clients with established cardiovascular disease.^{1,2}
- Treatment plans should be continuously reviewed for effectiveness, side effects, and patient burden.²

Addition of Basal Insulin to Non-insulin Therapies

- Clients who might benefit from combination therapy are:
 - Clients unable to achieve adequate control on non-insulin therapy alone.
 - Clients with severe hyperglycemia, especially in the presence of catabolic features (weight loss, ketosis, etc.) and symptoms.
- Benefits of combination therapy include:
 - Improved glycemic control with lower daily insulin requirements.¹⁻³
 - Fewer insulin injections, at least initially. This often makes the transition and acceptance of insulin therapy easier for clients.
- The addition of basal insulin, either human NPH or one of the longer-acting insulin analogues, to oral agent regimens is a well-established approach that is effective for many patients.²
 - Insulin in combination with metformin has been shown to result in less weight gain and fewer episodes of hypoglycemia than insulin alone or insulin in combination with secretagogues and is, therefore, the preferred combination (if there is no contraindication to metformin).^{1,2}
 - Basal insulin can be added to metformin, DPP-4 inhibitors, GLP-1 agonists, SGLT2 inhibitors, and even sulfonylureas unless contraindicated for the specific individual.^{1,2} Cost/affordability, regimen complexity, and patient preference should be considered.
- When insulin therapy is added to non-insulin therapy, the most widely-accepted insulin regimen is a single injection of basal insulin (intermediate-acting or long-acting insulin) with a starting dose of 10 units once daily, usually at bedtime.¹⁻⁴
 - It is also acceptable to have a starting dose of 0.1 to 0.2 units/kg of body weight² (e.g., for someone weighing 110 kg the starting dose could be 11 to 22 units).
 - Before suggesting a dose, consider how elevated the BG levels are, and the symptoms, as well as the client's thoughts on hypoglycemia and starting insulin.
 - A lower starting dose, slower titration and higher targets may be considered for the elderly and lower weight Clients.¹
- If using premixed insulin (containing a basal and prandial component) in combination with non-insulin therapy, the recommended starting dose is 5 to 10 units administered once or twice daily pre-breakfast and/or pre-supper.¹
 - Metformin can be maintained, but sulfonylureas and DPP-4 inhibitors are typically discontinued.²
- Dose adjustments:

Adjust basal dose by 2 to 4 units or 10 to 20% every two to three days until target FPG is reached, see examples below.⁴ (Note: Degludec should be titrated by 2 units every three to four days or 4

units once a week)¹ See page 58—next section under pattern management for complete guidelines.

- For example, if BG is:
 - 6 to 8 mmol/L, increase 1 unit
 - 8 to 10 mmol/L, add 10% of the TDD
 - greater than 10 mmol/L, add 20% of the TDD
- Special emphasis should be placed on increasing the bedtime insulin dose to normalize the fasting BG (versus adding additional insulin injections prior to achieving target fasting BG).¹⁻⁴
- If BG levels remain elevated later in the day as compared to the fasting BG, a change in regimen to multiple doses of insulin needs to be considered.¹⁻⁴
- Combining insulin with a thiazolidinedione (TZD) is not approved in Canada.² See Section 4, Table 4.4, page 178.

Addition of Prandial to Basal Insulin and Non-insulin Therapies

- Before adding meal (prandial) insulin, non-insulin therapy, especially secretagogues, may need to be decreased during the day to prevent hypoglycemia.¹⁻²
- The recommended starting dose of mealtime insulin is either 4 units or 10% of the basal dose at each meal.² Adjustments are based on SMBG results. Titrate every two to three days by 10% or 1-2 units² until SMBG targets (premeal or two-hr post meal) are achieved.¹⁻²
- As prandial doses increase, specifically at the evening meal, consideration should be given to decreasing the basal dose.² Reinforce the role of meal time insulin and CHO consistency (choices, amounts), starting with a ratio of 1 unit for 15 grams of CHO, to start. This will be adjusted quickly based on SMBG results and degree of insulin resistance.
 - There has been little difference shown between rapid-acting insulin analogues and human regular insulin on A1C or hypoglycemia in persons with type 2 diabetes.²
 - Starting with a single prandial dose at the largest meal is simple and effective, and can be advanced to multiple prandial doses if necessary.^{1,2}
 - Two doses of premixed human insulin is a simple convenient way of spreading insulin across the day², but takes away the flexibility of adjusting one insulin over the other.

Addition of Non-insulin Therapies to Basal Insulin

- Adding non-insulin therapy (SGLT-2, GLP-1, and DPP-4) to insulin has been shown to be an effective alternative for reaching blood glucose (BG) goals, improving A1C, reducing insulin requirements and possibly assisting in weight loss. As well some agents have proven cardiovascular and renal benefits in high-risk Clients.^{1,2,4}
 - While bedtime (basal) insulin is used to suppress nocturnal hepatic glucose production and improve fasting BG levels, non-insulin therapy may help to control daytime BG levels.
 - For some Clients (see below) non-insulin therapies could be considered before adding bolus/prandial doses with less risk of weight gain and hypoglycemia, depending on patient preference, cost/affordability, side effects, etc. For some, this may assist with weight reduction and reduced insulin requirements.
- Be aware that insulin needs may decrease when non-insulin therapies (oral/injectable medications) are added to the insulin regimen.
 - SGLT-2 inhibitors may be most helpful in Clients requiring large insulin doses, and reduce the amount of insulin needed.²

- While there is little written on specific reductions, clinical experience with SGLT-2 inhibitors and GLP-1 receptor agonists recommends a reduction by 20% of the TDD in Clients near/within target blood glucose range. This should be accompanied by teaching/caution re hypoglycemia (risks, prevention, treatment) and if hypoglycemia presents, the need for insulin dose reduction.
- DPP-4 inhibitors may decrease insulin needs but are less effective than SGLT-2 inhibitors and GLP-1 receptor agonists. As above, teach how to identify and treat hypoglycemia and how to decrease insulin dose if needed.
- Clients who might benefit from adding non-insulin therapy are:
 - Well-controlled type 2 diabetes clients on large doses of insulin (greater than 1 unit/kg of body weight).
 - Clients where basal insulin has been titrated to acceptable fasting blood glucose, yet A1C remains above target.²
 - Clients with established atherosclerotic cardiovascular disease (ASCVD) or heart failure (HF) or chronic kidney disease (CKD), where prandial insulin is being considered, but weight gain and hypoglycemia are concerns.

Examples only:

- ASCVD predominates: GLP-1 receptor agonists or SGLT2 inhibitors (if eGFR adequate), with proven benefit.
- HF or CKD predominates: SGLT-2 inhibitors.

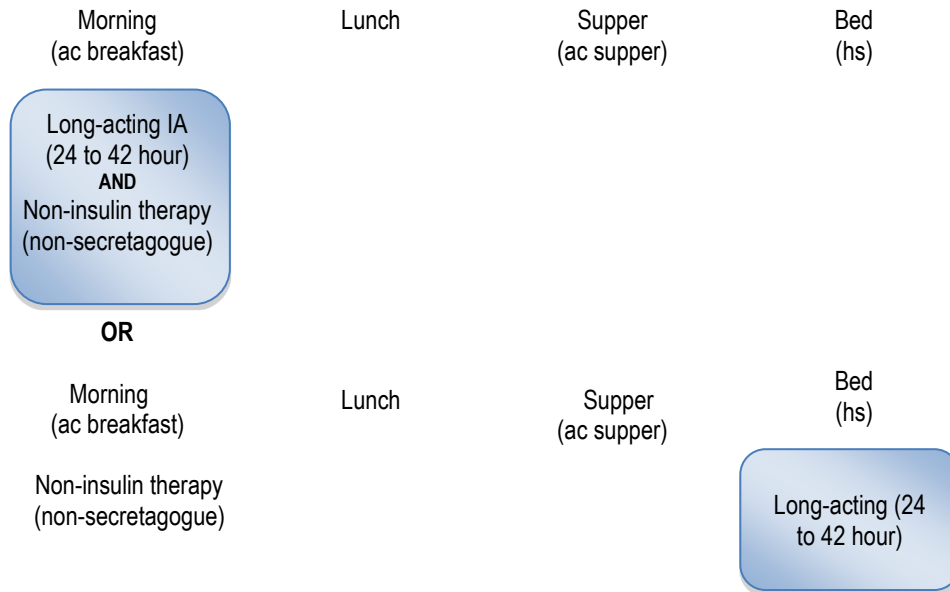
Addition of Injectable Non-insulin Therapy to Insulin

- May be useful in those Clients with acceptable FBG, but A1C remains above target.
- Benefits of adding injectable non-insulin therapy to insulin include:
 - Improved glycemic control with lower daily insulin requirements.¹⁻²
 - Fewer insulin injections, at least initially. This could make the transition and acceptance of insulin therapy easier for clients.
 - Less weight gain as often seen with the initiation of insulin therapy.
 - GLP-1 RA has a similar efficacy to insulin, however with lower risk of hypoglycemia and beneficial effects on weight, with greater GI side effects. High costs and tolerability are important barriers to consider.²
 - Fixed dual combinations (basal insulin plus GLP-1) could be considered.

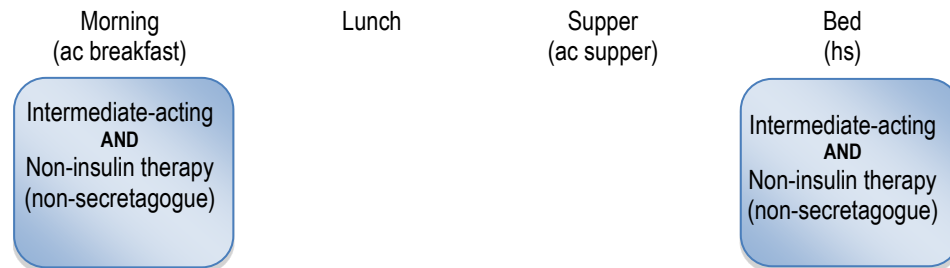
Examples:

1. Long-acting insulin analogue (24- to 42-hour) (morning or bedtime) plus non-insulin therapy.
2. Intermediate-acting insulin (morning or bedtime) plus non-insulin therapy.
3. Premixed insulin (morning and/or supper) plus non-insulin therapy (e.g., non-secretagogues).

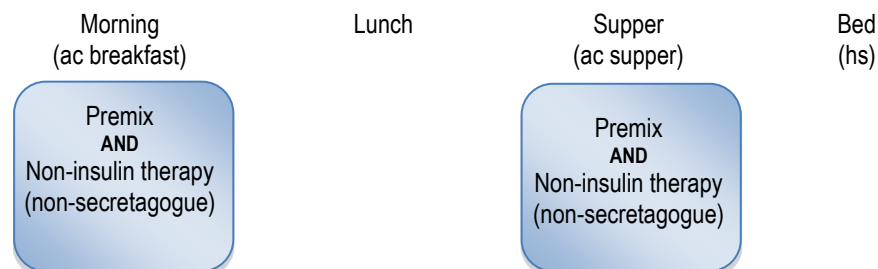
1.Example



2.Example



3. Example



References

1. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2018;42(suppl 1):S1-S325
2. American Diabetes Association. Standards of Medical Care in Diabetes -2019. *Diabetes Care*. 2019;42(suppl 1):S90-102.
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4. AACE/ACE Consensus Statement. Consensus Statement by the American Association of Clinical Endocrinologists and American College of Endocrinology on the Comprehensive Type 2 Diabetes Management Algorithm—2019 Executive Summary. *Endocrine Practice*. 2019;25(1):69-100.

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Case Study – Combination Therapy

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

Case Study 1: Combination Therapy

Narrative

Mrs. C. is a 60-year-old woman who has had type 2 diabetes for 10 years. They were originally started on metformin and then glyburide and sitagliptin were added two years ago because of persistent hyperglycemia. They follow their meal plan reasonably well, does housework daily, and goes bowling twice a week. They are starting to show proliferative retinopathy. They see their ophthalmologist regularly, but they are very worried about losing their sight. They are having consistently elevated BG, especially ac breakfast. They were reluctant but agreed to start insulin therapy. They were started on intermediate-acting insulin at bedtime and continued on their metformin 1000 mg BID and sitagliptin 100 mg daily and at this time Glyburide was discontinued.

Physical and Laboratory Findings

- Present weight is 75 kg
- BMI is 28
- Most recent A1C is 8.2%
- Fasting BG is 13.8 mmol/L
- eGFR is 55 mL/min
- Blood pressure is 140/75 mm/Hg

Current Diabetes Medication

- Intermediate-acting (IA) insulin 15 units at bedtime (75 kg x 0.2 units/kg = 15 units)
- Glumetza®
- 1000 mg BID
- Januvia ® 100 mg daily

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
May 1	11.0	7.0	5.4	6.8					IA 15 units	Bowling in afternoon.
May 2	10.6	8.2	6.8	8.7					IA 15 units	
May 3	11.9	6.4	7.8	7.3					IA 15 units	
May 4	12.1		7.5	7.0					IA 15 units	

Case Study 1 Combination Therapy Questions

1. What are the issues of most concern for this client?
2. What are the advantages of combination therapy for Mrs. C.?
3. What questions do you need to ask them today at their follow-up visit?
4. What recommendations for insulin adjustment would you make today? Include rationale.

Case Study Answer Sheet:

1. The areas of concern are:

- Poor glycemic control.
- Retinopathy; fear of losing sight; nephropathy, need to delay progression.
- Reluctance to start insulin. Needs reinforcement and encouragement to understand importance of BG control to prevent further progression of retinopathy.
- Client's initial reluctance to give herself insulin; needs reassurance they can do this.

2. The advantages of combination therapy are as follows:

- Easier for them to accept insulin therapy with one injection a day; easier to learn.
- A pen device would be used which would be helpful if eyesight does deteriorate. They may be surprised at how convenient it is.
- Insulin at bedtime will target the fasting hyperglycemia.
- The combination of insulin and Glucophage® causes less weight gain than other combinations. They are already overweight. They can still tolerate biguanide and DPP-4 Inhibitor with a eGFR of 55mL/min.
- This combination therapy may cause fewer hypoglycemic episodes; they are moderately active, and we want to encourage continued exercise/physical activity. (If they had frequent lows, they might eat more [weight gain] or stop their exercise/physical activity routine.)

3. You need to ask the following questions:

- How are they getting along with insulin administration? Are there any concerns or problems?
- What exercise/physical activity have they done in the last few days?
- How well are they following their meal plan? Do they need time with the dietitian today?
- Any other causes of elevated results? Explore before adjusting insulin.

4. What recommendations would you make? Include rationale.

- Increase bedtime intermediate-acting insulin to 17 units. The first goal is to improve the fasting BG.
- Explore other exercise/physical activity possibilities; for example, a walk after breakfast.
- Continue to adjust the dose by 2 units every three to four days until fasting BG has improved. An alternative would be to increase the dosage of intermediate-acting insulin by 1 unit every night until their fasting BG is in target. Early in therapy, the focus should be on improving fasting BG. Involve Mrs. C. in problem solving and making decisions regarding insulin adjustments. The goal is to empower the client to self-manage and to safely self-adjust the dose to the best of their ability.

Case Study 2: Combination Therapy (with established CV disease)

Narrative

Mr. T is a 63-year old man who was diagnosed with type 2 diabetes at age 43. At that time, he was started on Metformin twice a day and a sulfonylurea daily at breakfast. When Mr. T was 55 years old, he retired from the Military and was started on intermediate-acting insulin at breakfast at breakfast and at night time. Mr. T is being discharged from the hospital post MI that happened 5 days ago at the age of 63 and is being referred back to the Diabetes Centre for a diabetes refresher. During this admission, prior to discharge, he was started on SGLT-2 inhibitor and a GLP-1 receptor antagonist.

Physical and Laboratory Findings

- Present weight is 260 lbs. (118 Kg); Ht: 5' 11" (180 cm)
- BMI is 36.4
- Most recent A1C 9.6%
- Fasting BG 12.5 mmol/L
- eGFR 65 mL/min
- B/P 135/85

Current Diabetes Medication:

- Diamicon MR 120 mg breakfast
- Glumetza 1000mg bid
- Jardiance 25 mg once daily
- Ozempic 0.5 mg once weekly
- Intermediate-acting (IA) insulin 30 units breakfast and 35 units hs
- ASA 81 mg
- Rosuvastatin 10 mg once daily
- Perindopril 4mg once daily

Recent SMBG Results:

DATE	BLOOD GLUCOSE				INSULIN	
	ac bkfst	ac lunch	ac supper	hs bed	0800	2200
July 1	10.6	-	13.1	14.1	IA 30 units	IA 35 units
July 2	12.5	-	-	14.1	IA 30 units	IA 35 units
July 3	11.6	14.6	-	15.1	IA 30 units	IA 35 units
July 4	11.8	-	-	13.2	IA 30 units	IA 35 units
July 5	12.1	-	13.8	-	IA 30 units	IA 35 units
July 6	10.0	-	-	13.1	IA 30 units	IA 35 units

Case Study 2 Combination Therapy (with established CV disease) Questions

1. What are the issues of most concern for this client?
2. What are the advantages of combination therapy for Mr. T.?
3. What questions do you need to ask them today at their follow-up visit?
4. What recommendations for insulin adjustment would you make today? Include rationale.

Case Study 2 Answer Sheet

1. The areas of concern are:

- Mr. T's SBGM results remain elevated on combination therapy with insulin.
- He is overweight and his blood pressure is not well controlled.
- Recent MI, with established cardiovascular disease.
- He is taking a number of diabetes medications.
- Some non-insulin therapies may positively impact weight and reduce BG, and could increase the risk of hypoglycemia; they also have additional side effects/costs that should be reviewed to ensure he continues to take these medications. Medication persistence is important and should be reviewed.

2. The advantages of combination therapy are as follows:

- An SGLT-2 inhibitor and the GLP-1 receptor agonist will offer cardiovascular protection as well as improve blood glucose and BP. He may no longer need the Diamicon MR.
- He may experience needed weight loss to improve insulin resistance.
- He could be placed on a longer acting insulin analogue if there was a fear of hypoglycemia and this could reduce the need for two injections a day.
- Bolus (prandial) insulin may not be required with the addition of these non-insulin therapies.

3. You need to ask the following questions:

- How is he getting along with insulin administration? Are there any concerns or problems? You may want to observe an insulin injection as he has been doing this for a long time.
- How often does he rotate his injection sites, and reuse his needles?
- Is his current medication routine affordable/acceptable? Does he still have coverage with the military, as it provides 80% coverage?
- Has he experienced hypoglycemia, when and under what circumstances and how would he prevent/treat this?
- Is he willing to test more frequently to make better blood glucose evaluations?
- Does he have any symptoms/side effects that may reduce medication persistence?
- Is closer follow-up possible as he will have a lot of changes to his medication regime.

4. What recommendations would you make? Include rationale?

- Recommend testing more frequently to assess his medication needs. He may no longer need the Diamicon MR, ask him to test at supper to assess for hypoglycemia.
- He will need to watch the supper time reading to make sure he doesn't go low at that time. He may need to lower his am NPH dose or even lower his Diamicon at breakfast.
- Recommend that he increase his insulin over night by 2 units every 3 days until his morning reading has improved.
- Do not increase the morning dose yet because there are not enough SBGM results to make a safe increase in the dose.
- Make sure the he knows how to properly treat hypoglycemia as well as being aware of the current driving guidelines with hypoglycemia. Follow-up by phone in a week.
- Talk about the longer acting insulin analogues to see if this would be affordable for him. If yes, we could talk about changing from NPH to something longer lasting. (Remember that when changing from a bid insulin to a once daily insulin injection that there should be a 20% reduction in the total daily dose of insulin).

Pattern Management

Pattern management is defined as making changes to an insulin dose based on two to three days' worth of consistently fluctuating (high or low) blood glucose (BG) results occurring at the same time each day when everything else is the same (e.g., activity, food and injection sites).

Basic Steps

- Set and clarify target BG goals with client.
- Ensure accuracy of SMBG results with periodic assessment of client's technique, lab/meter comparison, and A1C.
- Ensure a plan is in place for reasonably consistent carbohydrate (CHO) intake and physical activity levels while dose adjustments are being made.
- Have client monitor BG ac meals and at bedtime. Insulin adjustments are initially made on preprandial results. Test overnight (0300 hours) to assess changes to bedtime insulin or to rule out nocturnal hypoglycemia after exercise.
- When a short-acting insulin or rapid-acting insulin analogue is used, postprandial (2-hour pc) BG monitoring will help fine-tune mealtime insulin dose. (Note: 1-hour pc SMBG is used in relation to pre-conception and pregnancy care.)
- Fingertip testing (rather than alternate site testing) is preferred after meals, when medication action is peaking, after exercise/physical activity, and during hypoglycemia.¹
- Continuous glucose monitoring (CGM—real-time [rt] or intermittently scanned [is]—Flash) can be an adjunctive method (complementary to SMBG) for the assessment of glucose levels; and with some systems, it is considered non-adjunctive (stand-alone without the support of SMBG).² Integrating these results can be useful for adjusting prandial insulin doses, but requires proper review and interpretation of the data by both the patient and the provider to ensure effective and timely use.²
 - rtCGM: Using ambulatory glucose profiles will help with interpretation and to guide treatment decisions. Trend and predictive information will be valuable in determining dose adjustments
 - isCGM: Retrospective review of data will assist with therapy change. Routine (consistent) scanning, at specified times of day will be needed to determine patterns.
- Assess patterns or trends of BG results over at least two to three days.
- Consider other factors that may be causing the pattern:
 - Food intake
 - Over-treatment of hypoglycemia
 - Activity level (e.g., seasonal)
 - Too much or too little insulin
 - Menstrual cycle
 - Timing of injections
 - Presence of illness/infection
 - Alcohol intake
 - Injection sites and rotation

If the diabetes educator certified in insulin dose adjustment feels changes in the insulin regimen are indicated, such as number of injections or type of insulin, this should be done in collaboration with the referring prescriber.

- Accuracy of meter and strips
- Insulin storage
- Improper use of insulin delivery device
- Medications (i.e., niacin, steroids, chemotherapy, etc.)
- Identify the insulin that has the greatest effect on the BG pattern/trend.
- Usually change only one insulin at a time.
- **See page 58 for insulin adjustment (titration) guidelines for basal and prandial (bolus) insulins.**
- If both hypoglycemia and hyperglycemia are present, **adjust for hypoglycemia first**. If all BG results are comparably elevated, usually start with adjusting for the fasting BG.
- In some cases, it may be appropriate to adjust more than one insulin dose simultaneously. E.g., if breakfast and supper BG levels are high at the same time, then the intermediate-acting insulin could be increased at breakfast and nighttime.
- Consider all BG results that may be affected by the dose adjustment.
- Leave the change for two to three days to see how the peaking insulin will affect the current patterns. If results remain very elevated during this time, the client should be instructed to contact the physician/diabetes educator.
- Arrange follow-up to review SMBG results in three to four days. Advise the client or family to call sooner if they are experiencing frequent hypoglycemic reactions or has other concerns. (According to local policy, telephone, fax, e-mail or office visits can be used to communicate results/adjustments.)
- Most clients should be instructed in insulin dose adjustment. Self-titration is known to be effective.⁴
- Discuss rationale for all dose adjustments, and use guided problem solving to promote understanding and support client learning.
- Continue dose adjustments until BG levels are in the target range.
- Follow-up intervals may lengthen as SMBG results reach target and/or the client becomes proficient at adjusting their own insulin.

It is essential that individuals understand pattern management before progressing to more advanced insulin dose adjustment.

INSULIN ADJUSTMENT (TITRATION) GUIDELINES

Basal Insulin:

- With a starting dose of 0.1 to 0.2 units/kg BW^{3,4} or 10 units^{1,4}, adjust basal dose by two to four units or 10 to 20% every two to three days until target FPG is reached, see examples below. (Note: Degludec should be titrated by 2 units every three to four days or 4 units once a week)¹

For example, if BG is:³

- 6 to 8 mmol/L, increase 1 unit
- 8 to 10 mmol/L, add 10% of the TDD
- greater than 10 mmol/L, add 20%.

For hypoglycemia, determine and address cause, decrease dose by 4 units or 10-20%.³

Note: When trying to teach self-titration, adjust by 1 unit per day until FPG target is achieved.¹ Attainment of target will be slower.

Examples (basal insulin) titration:

- Mary is taking 10 units of long-acting (LA) 24-hour insulin. The FPG remains unchanged over the first month (around 12 mmol/L), increase by 2-4 units or 20% (2 units), assess, and then continue titration as needed.³
- Jeff is taking 30 units of LA 24-hour insulin. The FPG is approaching target at 8 mmol/L, as John is self-titrating, adjust by 1 unit every day until target FPG is reached.
- Colin is taking 20 units of a U-100 LA 42-hour insulin. The FPG remains above target at 10 mmol/L, increase by 2 units every three to four days, or 4 units weekly.

Prandial (bolus) Insulin:

- With a starting dose of 10% of the basal dose⁴ or 2-4 units¹, at the largest meal or breakfast, titrate every two to three days by 10%³ or 1-2 units³ until SMBG targets (premeal or 2-hr post meal) are achieved.

For hypoglycemia, determine and address cause, decrease corresponding dose by 2-4 units or 10-20%.³

Note: When trying to teach self-titration, adjust by 1 unit per day until pre-meal or 2-hour post-meal target PG is achieved.¹

Examples (bolus insulin) titration:

- Sarah is taking 40 units of intermediate acting (IA) insulin and 4 units of short acting (SA) insulin at supper. The ac supper BG is 6.8 mmol/L and the 2-hour pc BG is 12 mmol/L, increase the SA insulin by 1 unit every two to three days until 2-hour pc is to target.
- John is taking 104 units of long acting (LA) 24-hour insulin U-300 at breakfast and 30 units of rapid acting (RA) insulin at the largest meal. The 2-hour-pc is greater than 10 mmol/L, increase the RA insulin by 3 units to 33 units (10% of the RA insulin). **Note: As the mealtime insulins are increased, there may be need to lower the LA insulin at breakfast.**
- Martha is taking 60 units of IA at bedtime, with 8 units of RA at breakfast, 12 units RA at lunch, and 16 units of RA at supper. Ac supper BG readings are between 12-14 mmol/L and the 2-hour pc values are between 7-10 mmol/L (within target). Increase the lunch RA dose by 2 units until the ac supper BG (or 2-hour pc) values are within target. **Note: There may be need to lower the supper RA as the ac supper BG improves.**

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1. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2018;42(suppl 1):S90-102.
2. Edelman SV, Argento NB, Pettus J, Hirsch IB. Clinical implications of real-time and intermittently scanned continuous glucose monitoring. *Diabetes Care*. 2018;41(11):2265-2274.
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Recommended Reading

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Supplemental Dose Adjustment

Supplements are temporary insulin adjustments to the rapid- or short-acting insulin dose to compensate for hyperglycemia or hypoglycemia:

- **Hyperglycemia:** Usual insulin dose is increased.
- **Hypoglycemia:** Usual insulin dose is decreased.

There are two types of supplemental adjustments:

- **Compensatory:** Adjustment to correct for an immediate high or low BG result. Compensate.
- **Anticipatory:** Adjustment in advance of planned exercise/physical activity or food intake. Anticipate.

Compensatory Dose Adjustments

- A variable insulin dose algorithm can be developed to guide a client in making compensatory insulin dose adjustments. Clients should be involved in the development of the algorithm as it will not be the same for everyone.
- Algorithms should be developed after pattern management is established.

Tips for Constructing a Variable Insulin Dose Algorithm

- Consider the client's target range for BG control.
- Consider the client's willingness and ability to use a variable insulin dose algorithm.
- Ensure variable dose adjustments are made in conjunction with pattern management adjustments.
- Consider the client's sensitivity to rapid- or short-acting insulin. Sensitivity varies from person to person.
- Construct the algorithm conservatively, i.e., err on the side of hyperglycemia initially.
- Calculate the client's insulin sensitivity factor (ISF). *See Calculating the Insulin Sensitivity Factor (ISF) or Correction Factor, page 61.*
- The ISF (or Correction Factor) is defined as the glucose lowering effect of 1 unit of insulin over 2 to 4 hours.
- Usually an additional 1 unit of insulin is needed for every 2 mmol/L increase in BG. Algorithms may be designed to fit each individual's needs (i.e., in increments of 1 to 3 units or more). This can vary significantly based on type of diabetes, level of physical activity, or client's weight.
- In most cases, limit the total amount of additional rapid- or short-acting insulin to 5 or 6 units in the algorithm or not more than 10% TDD.
- Algorithms are usually applied at times when the client routinely takes rapid- or short-acting insulin (i.e., ac meals).
- Calculating an effective variable insulin dose algorithm is a process of trial and error and will take time.
- Evaluate for effectiveness and revise as necessary.

Calculating the Insulin Sensitivity Factor (ISF) or Correction Factor¹⁻⁴

- The ISF formula provides an estimated starting point only. It will need to be individualized and modified based on the client's SMBG results and insulin dose records (past and present).
- ISF estimates the drop in BG (mmol/L) per unit of rapid- or short-acting insulin over 2 to 4 hours.
- ISF is calculated by dividing the TDD into 100 when using rapid-acting insulin or into 83 when using short-acting insulin.

The ISF formula provides an estimated starting point only. It will need to be individualized and modified based on the client's results.

$$\text{ISF} = \frac{100}{\text{TDD}} \text{ (rapid-acting insulin)} \qquad \text{ISF} = \frac{83}{\text{TDD}} \text{ (short-acting insulin)}$$

- It is possible to have more than one ISF; e.g., a higher sensitivity number overnight for clients with a history of hypoglycemia unawareness or nocturnal hypoglycemia, as well as setting higher BG target values overnight. Similarly, clients may have a lower ISF at breakfast due to dawn phenomenon.
- The lower the ISF number, the more insulin is given for a correction dose.
- Adjustments may be required during puberty, weight change, physical activity, and illness.

Example:

Sarah is a 24-year-old woman with type 1 diabetes. They take the following:		
Before breakfast:	Intermediate-acting insulin	10 units
	Rapid-acting insulin	6 units
Before lunch:	Rapid-acting insulin	5 units
Before supper:	Rapid-acting insulin	5 units
At bedtime:	Intermediate-acting insulin	<u>8 units</u>
TOTAL DAILY DOSE (TDD)		34 units
Their target BG is 4 to 7 mmol/L ac meals. Sarah's TDD is 34 units, and they use rapid-acting insulin.		
Sarah's ISF is $\frac{100}{34} = 2.9$ mmol/L (3 mmol/L)		
That is, 1 unit of rapid-acting insulin will lower her BG by approximately 3 mmol/L over 2 to 4 hours.		
If Sarah was using short-acting insulin:		
Sarah's ISF would be $\frac{83}{34} = 2.4$ mmol/L (2 mmol/L)		
That is, 1 unit of short-acting insulin would lower her BG by approximately 2 mmol/L over 2 to 4 hours.		

Sarah’s starting algorithm using rapid-acting (RA) insulin is below. Their variable insulin dose algorithm would need to be revised based on their SMBG results.

IA = Intermediate-acting RA = Rapid-acting

BG (mmol/L)	Basal Insulin	Bolus Insulin				Basal Insulin
		Breakfast (B)	Lunch (L)	Supper (S)	Snack/hs	
Less than or equal to 4.0		-1	-1	-1		
4.0 to 7.0 (Target)	IA 10 units (AM)	RA 6 units	RA 5 units	RA 5 units	RA*	IA 8 units (hs)
8.0 to 11.0		+1	+1	+1		
11.1 to 14.0		+2	+2	+2		
14.1 to 17.0		+3	+3	+3	1	Check ketones
17.1 to 20.0		+4	+4	+4	2	Check ketones
greater than or equal to 20.0		+4	+4	+4	2	Check ketones

* Use of rapid-acting insulin at bedtime is not usually recommended because of the risk of nocturnal hypoglycemia. However, a conservative supplement for excessively elevated BG readings at bedtime is sometimes used.

Anticipatory Dose Adjustments

- CHO counting (calculating the insulin-to-CHO ratio) is the most common method used for making anticipatory dose adjustments for planned exercise/physical activity or food intake.
- Insulin-to-CHO ratios enable a person to adjust insulin doses according to how much CHO will be eaten. This allows for more flexible insulin therapy and is one of the many benefits of switching to multiple daily injections.
- It is important for the client to maintain a reasonably consistent CHO intake while determining the insulin-to-CHO ratio, as it will help to establish the ratio per meal more accurately.
- The usual insulin-to-CHO ratio in adults is 1 unit of insulin per 10 to 15 grams CHO but must be individualized.
- If short-acting insulin is used, CHO counting includes all CHO consumed within a meal period. A meal period includes meals plus any snacks before the next meal.²
- If rapid-acting insulin is used, CHO counting includes all CHO consumed at the meal. An injection before snacks may be required if the CHO content is significant. This is individualized.
- To match the insulin dose and CHO intake as accurately as possible, the insulin-to-CHO ratio is used for pre-meal times only.
- A wide range of insulin-to-CHO ratios is possible, depending on the client’s sensitivity to insulin.

Insulin-to-CHO ratios vary from person to person and may differ from meal to meal in the same individual.

- Insulin-to-CHO ratio effectiveness is verified by two-hour pc BG testing (or one-hour pc testing during pregnancy or pre-conception).
- It is best to check the two-hour pc meal for carbohydrate accuracy when the pre-meal glucose is at target.

Calculating the Insulin-to-CHO Ratio ²

To calculate the insulin-to-CHO ratio, divide the total grams of CHO (minus fiber) in the meal by the number of units of insulin to be taken.

$$\frac{\# \text{ grams of CHO/meal}}{\# \text{ units of insulin}} = \text{Insulin-to-CHO Ratio}$$

Example:

Luke's breakfast has a total CHO content of 65 grams. They also have a morning snack containing 25 grams. They take 6 units of short-acting insulin before breakfast. To determine the insulin-to-CHO ratio:

$$\frac{\# \text{ grams of CHO/meal (plus snack)}}{\# \text{ units of insulin}} = \frac{65 + 25 = 90}{6} = 15$$

Luke's insulin-to-CHO ratio is 1 unit of insulin to 15 grams of CHO.

This is confirmed by a 2-hour pc BG within target range.

Calculating the Insulin Dose Using CHO Counting ^{1,2}

To use the insulin-to-CHO ratio to determine an insulin dose, a rule of thumb is to assume 1 unit of insulin for every 10 to 15 grams of CHO; and use the following equation:

$$\frac{\# \text{ grams of CHO/meal}}{\text{grams CHO per 1 unit insulin}} = \text{Insulin Dose}$$

Example:

Betty's breakfast has a total CHO content of 56 grams, including 5 grams of fiber. They do have a morning snack. Using the insulin-to-CHO ratio of 1 unit of insulin/10 grams CHO, calculate the amount of insulin they need to take to cover the CHO in their breakfast.

$$56 \text{ grams} - 5 \text{ grams} = 51 \text{ grams}$$

$$\frac{51 \text{ grams CHO/meal}}{1 \text{ unit insulin/10 grams CHO}} = \frac{51}{10} = 5.1 \text{ units (5 units)}$$

Betty would take 5 units of rapid- or short-acting insulin to cover the CHO in their breakfast, which would be verified by BG in target range 2 hours pc or at the next meal.

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Recommended Reading

- Fine tuning control: pattern management versus supplementation. *Diabetes Spectrum*. 2001;14(2):75-78. Website: <https://spectrum.diabetesjournals.org/content/14/2/75>. Accessed January 2020.
- Home P, Riddle M, Cefalu WT, et al. Insulin therapy in people with type 2 diabetes: opportunities and challenges. *Diabetes Care*. 2014; 37(6):1499-1508.

Changing to Intensive Diabetes Therapy

Intensive insulin therapy is the matching of insulin dosing to food, activity and life events with individual adjustments to insulin regimens.¹

Key Points

- Intensive diabetes therapy includes a basal/bolus insulin regimen of multiple daily injections (MDI). The Diabetes Control and Complications Trial (DCCT), along with the follow-up study Epidemiology of Diabetes Interventions and Complications (EDIC), clearly demonstrated that successful intensive diabetes therapy substantially reduced the development and/or progression of long-term microvascular complications in type 1 diabetes.^{2,3} Further study also demonstrated the beneficial effects of intensive therapy on the incidence of cardiovascular disease in type 1 diabetes that persist for up to 30 years.⁴ The United Kingdom Prospective Diabetes Study (UKPDS) showed a 25% risk reduction in microvascular endpoints with more intensive therapy for type 2 diabetes.⁵
- Safe and effective implementation of intensified diabetes therapy requires that the client is willing and able to actively participate in treatment and problem solving and that there is a trained and motivated diabetes health care team (HCT) to provide the client with the necessary education, skills, and support needed.
- In older Clients with a long duration of diabetes and multiple comorbidities, intensive therapy is not recommended.⁶ Key elements of intensive diabetes therapy include the following:
 - The use of four or more daily insulin injections or insulin pump therapy (basal-bolus regimen)
 - Frequent SMBG up to three to four times a day
 - Individualized target BG levels
 - Careful balance of food intake, activity, and insulin dose
 - Self-adjustments of food intake, insulin dose, and use of insulin
 - Frequent contact with the diabetes HCT concerning diabetes management (initially)
 - Education on how to do intensive therapy
 - Psychological support
 - Development of mutually negotiated goals for health and diabetes self-care
 - Regular objective assessment of A1C, SMBG records, and frequency/severity of hypoglycemia and adjustment of goals/plan based on this information
- With intensive basal/bolus regimens, the insulin dose is divided into basal and bolus injections. Generally, 40 to 60% of the TDD provides the basal insulin, and the remainder is divided into bolus doses to match food intake.⁶
- When switching to MDI, it is imperative to review the client's previous experience/history with response to insulin (i.e., insulin sensitivity), as any change in insulin therapy must be individualized. *See Supplemental Dose Adjustment, page 60.*
- When switching from intermediate-acting insulin once daily to a long-acting insulin analogue, the number of units of insulin should remain the same.
- When switching from intermediate-acting insulin twice daily to a long-acting insulin analogue, the number of units should be decreased by 20%.
- Increased frequency of SMBG ac and two-hour pc meals for the first one to two weeks is recommended when switching to basal/bolus regimens.

- Real time (rt) CGM system or intermittently scanned [is]—flash glucose monitoring (FGM) system can be used as a clinical tool to fine-tune insulin therapy in select clients.
 - Potential benefits of CGM include the identification of hypoglycemic unawareness or overnight hypoglycemia as well as the ability to discern the glycemic effect of meals, exercise/physical activity, insulin, medications, and stress.

It is important to remind patients that when using isCGM that they need to swipe the sensor at least every eight hours to capture continuous glucose results to look for patterns. Remind patients that with flash glucose monitoring there are no alerts or alarms that can be set to detect high or low glucose levels but it is found on review of the data.⁶ This information can then be used for individual analysis, interpretation, and regimen changes to help improve and/or maintain optimal glycemic control.

Calculating Basal and Bolus Requirements

Step 1: Calculate the TDD of insulin

- Add the sum of all current insulin doses and reduce by 10 to 25%.

Current TDD - 10 to 25% = New TDD (usual reduction is 20%)

OR

- Reduce basal by 10 to 25% and boluses by 10 to 25% if not using insulin-to-CHO ratios.

Step 2: Calculate basal insulin requirements

- Basal requirement = 40 to 60% of new TDD which can be given as:
 - Intermediate-acting insulin divided into ac breakfast and bedtime or bedtime only.
 - Long-acting insulin analogue (glargine; detemir) once a day.
 - Basal (units/hour) with Continuous Subcutaneous Insulin Infusion (CSII).

(If there is a fear of hypoglycemia or actual hypoglycemic events err on the side of caution and use 40%. If BG levels are elevated, use 60%.)

Step 3: Calculate bolus (meal) requirements

- Total bolus (meal) requirements = TDD - basal insulin

There are several ways to determine pre-meal boluses of rapid- or short-acting insulin such as the following: (A or B or C)

A) Determined as a percentage of the TDD depending on the meal size/composition.

- 15 to 25% TDD ac breakfast
- 10 to 20% TDD ac lunch
- 15 to 20% TDD ac supper

B) Determined as a percentage of the total **meal** doses (TMD)

- 35% TMD ac breakfast
- 30% TMD ac lunch
- 35% TMD ac supper

C) Determined by calculating the insulin-to-CHO ratio for each meal using CHO counting. The usual adult insulin-to-CHO ratio is 1 unit of insulin to 10 to 15 grams of CHO, but it must be individualized. *See Calculating the Insulin-to-CHO Ratio, page 63.*

These formulas provide an estimate of the starting insulin requirements only. They will need to be individualized and modified based on SMBG results.

Increased frequency of SMBG ac meals, and 2-hours pc for the first 1 to 2 weeks is recommended when switching to MDI regimens.

Based on the formula used, there may be some slight variation in individual doses when switching to MDI. Again, doses will be fine-tuned based on SMBG results.

Example:

Client's current dose is: Intermediate-acting 30 units and short-acting 10 units ac breakfast. Intermediate-acting 20 units and short-acting 8 units ac supper. Fear of hypoglycemia exists.	
Step 1: Current TDD = 30 + 10 + 20 + 8	= 68 units
Current TDD – 20%	= New TDD = 68 – [(68 x 0.20) = 13.6 (14 units)] = 68 – 14
<u>New TDD</u>	= 54 units
Step 2: Basal requirements	= 40 to 60% of New TDD = 0.40 x 54 = 21.6 (22 units)
<u>Basal requirements</u>	= 22 units
Step 3: Bolus (meal) requirements	= TDD – Basal insulin = 54 – 22
	<u>= 32 units</u>
A) Determined as percentage of TDD	
25% TDD ac breakfast	= 0.25 x 54 = 14 units ac breakfast
15% TDD ac lunch	= 0.15 x 54 = 8 units ac lunch
20% TDD ac supper	= 0.20 x 54 = 11 units ac supper
	<u>Total Bolus = 33 units</u>
OR	
B) Determined as percentage TMD	
35% TMD ac breakfast	= 0.35 x 32 = 11 units ac breakfast
30% TMD ac lunch	= 0.30 x 32 = 10 units ac lunch
35% TMD ac supper	= 0.35 x 32 = 11 units ac supper
	<u>Total Bolus = 32 units</u>
OR	
C) Determined by calculating insulin-to-CHO ratio.	

References

1. Diabetes Canada *Building Competency in Diabetes Education: Advancing Practice 3rd Edition*. Toronto, ON: Author; 2014.
2. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin dependent diabetes mellitus. *New England Journal of Medicine*. 1993;329:977-986.
3. The Epidemiology of Diabetes Interventions and Complications (EDIC). *New England Journal of Medicine*. 2005;353(23):353(25).
4. The Diabetes Control and Complications Trial (DCCT)/Epidemiology of Diabetes Interventions and Complications (EDIC) Study Research Group Intensive Diabetes Treatment and Cardiovascular Outcomes in Type 1 Diabetes: The DCCT/EDIC Study 30-Year Follow-up. *Diabetes Care*. 2016;39(5):686-69.
5. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*. 1998;352:837-853.
6. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2018;42(Suppl1):S1-S325.

Recommended Reading

- Diabetes Canada. *Building Competency in Diabetes Education: The Essentials 5th Edition*. Toronto, ON: Author; 2019.
- Optimal Therapy Recommendations for the Prescribing and Use of Insulin Analogues. Canadian Agency for Drugs and Technologies in Health May 2009. Website: https://www.cadth.ca/media/pdf/compus_IA_OT_rec_report.pdf . Accessed January 2020.
- Walsh J, Roberts R, Varma C, Bailey T. *Using Insulin: Everything You Need for Success with Insulin*. San Diego, CA: Torrey Pines Press; 2003.

Case Studies – Changing to Intensive Diabetes Therapy

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

Case Study 1: Changing to Intensive Diabetes Therapy

Narrative

Jamie is a 32-year-old male who has had type 1 diabetes for 20 years. Their last visit to a DC was 8 years ago. They have not seen diabetes specialist physician since they last attended a pediatric facility 14 years ago. Recently, Jamie has been diagnosed with hypertension, renal disease, and dyslipidemia. Upon referral to the endocrinologist, his history reveals that Jamie usually feels his hypoglycemic episodes; and they have become increasingly concerned about his ac breakfast values (variable lows and highs; a possible indication of nocturnal hypoglycemia). They did require paramedic intervention for a severe hypoglycemic episode after supper in the past year. Their wife is supportive of measures to improve diabetes management.

Physical and Laboratory Findings

- Present weight is 85.1 kg
- Most recent A1C is 8.6%
- Blood pressure is 110/70 mm/Hg

Current Diabetes Medication

- Intermediate-acting (IA) insulin 26 units; short-acting insulin 16 units ac breakfast
- Intermediate-acting (IA) insulin 15 units; short-acting insulin 14 units ac supper

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
April 10	3.0	4.1	12.1	2.0		IA 26 units SA 16 units		IA 15 units SA 14 units		
April 11	17.9	9.4	6.3	3.1						
April 12	4.0	17.6	2.0	21.1						
April 13	14.0	20.2	3.2	7.0						

Case Study 1 Changing to Intensive Diabetes Therapy Questions:

1. The attending endocrinologist/internist orders a more intensive (basal/bolus) regimen for Jamie using a long-acting analogue and a rapid-acting analogue. What would you need to discuss and/or review with Jamie to prepare them for a more intensive insulin regimen?
2. What would be important to consider for Jamie before switching to basal/bolus therapy?
3. Jamie is now ready to switch to basal-bolus therapy following adequate preparation by their diabetes HCT.
 - a) Briefly define the terms basal and bolus (meal) insulin requirements in intensive insulin regimens.
 - b) For each step, provide the rationale for the method used as well as the calculation.

Step 1: Determine the TDD to be used.

Step 2: Provide the calculations and rationale in determining basal insulin requirements.

Step 3: Determine the pre-meal doses by using the insulin-to-CHO ratio method. The following CHO composition for each meal/snack has been calculated from Jamie's meal plan:

<u>Breakfast</u>	<u>Lunch</u>	<u>Supper</u>	<u>Bedtime Snack (hs)</u>
135 grams	120 grams	150 grams	30 grams

- c) What recommendations would you give Jamie as he begins their MDI regimen?
4. In the future, an insulin algorithm may be developed (this will assist Jamie to further enhance his glycemic control).
 - a) What should be considered before proceeding?
 - b) Construct an algorithm for Jamie. Show appropriate calculations.

Case Study Answer Sheet

1. In preparation, Jamie must be aware of the rationale for promoting intensive therapy. Discuss the following key points:

- A basal-bolus regimen is designed to help achieve normal or near-normal BG levels by attempting to mimic physiologic insulin.
- What the key elements of a basal-bolus regimen are and if they have any concerns/questions.
- Intensive diabetes therapy, resulting in improved control, substantially reduces (39% to 76%) the development and/or progression of long-term microvascular complications in type 1 diabetes. It is especially important for Jamie who has recently learned that they have developed renal disease. Basal-bolus therapy may slow progression.
- Jamie will be able to be an active participant in the planning and implementation of his basal-bolus therapy regimen.
- His wife is supportive.

2. Important considerations include:

- Does Jamie have extended health insurance for the increased cost of insulin analogues and BG monitoring strips for the additional SMBG? (*See section 4, Table 4.1, page 171.*)
- Current knowledge/understanding of insulin, time action, injection sites, rotation of sites, etc.
- Frequency/severity of hypoglycemia - signs and symptoms, causes, and treatment.
- Present frequency of SMBG and record keeping.
- Individualized target BG levels.
- Motivation and willingness to follow through and work with the diabetes HCT.
- Frequency of contact between Jamie and the diabetes HCT.
- Cognitive and/or physical challenges.
- Psychological/socio-economic supports needed.
- Education re: effective intensive therapy (e.g., CHO counting, insulin-to-CHO ratio, etc.).
- Regular objective assessment of A1C and SMBG records.
- Time required for adequate preparation.
- Meal plan review for health concerns.

3a. Basal dose insulin refers to the intermediate-acting insulin BID or long-acting insulin analogue given as one dose (usually at bedtime) or BID. This helps to sustain optimal glycemic control in conjunction with the insulin dosing associated with the meal period.

- Bolus (meal) requirements see the amount of rapid- or short-acting insulin given as a pre-meal bolus to cover the CHO content of the meal.

3b. Calculating the doses (*see page 60*):

Step 1: Current TDD - 10 to 25% = new TDD **71 units - 15% = 60 units**

Fifteen percent (15%) was chosen because of his history of hypoglycemia and current SMBG report, which had an equal number of high and low BG results.

Step 2: Basal requirement = 40 to 60% of the new TDD **60 units x 0.50 = 30 units**

Fifty percent (50%) was chosen, as it is a safe mid-range and considers recent BG results and

episodes of hypoglycemia.

Step 3: Bolus/ mealtime requirements:

The usual insulin-to-CHO ratio is 1 unit of insulin to 10 to 15 grams of CHO.

The ratio of 1 unit/15 grams of CHO will be used to err on the side of caution and prevent hypoglycemia.

$$\text{B: } \frac{135}{15} = 9 \text{ units}$$

$$\text{L: } \frac{120}{15} = 8 \text{ units}$$

$$\text{S: } \frac{150}{15} = 10 \text{ units}$$

$$\text{hs: } \frac{30}{15} = 2 \text{ units}$$

NOTE: Insulin-to-CHO ratio should always be fine-tuned using 2-hour pc meal testing and discussed with the physician/diabetes HCT. Insulin-to-CHO ratio varies from person to person and may differ from meal to meal in the same individual.

Jamie's new MDI regimen and starting insulin doses are:

$$\text{B: RA} = 9 \text{ units}$$

$$\text{L: RA} = 8 \text{ units}$$

$$\text{S: RA} = 10 \text{ units}$$

$$\text{hs: LA} = 30 \text{ units}$$

$$\text{RA} = 2 \text{ units}$$

3c. Recommendations as Jamie starts to use his new dose are:

- Increase frequency of SMBG ac meals and 2-hours pc for the first one to two weeks.
- Phone/fax/e-mail (as per NSHA Zone/IWK/facility policy) SMBG and CHO counting records to be reviewed by the diabetes health care team.
- Dietitian and nurse will reinforce tight adherence to meal plan (structure before flexibility) to assess effective CHO counting methods employed.
- Explain to Jamie that these formulas provide a starting point for insulin requirements for a MDI regimen. They will need to be individualized and modified based on their SMBG results.
- Involve Jamie in problem solving to support learning and self-care practices.

4a. Important points to consider before proceeding with use of an algorithm include:

- Wait until pattern management is established.
- Wait until ISF is known or calculated.
- Ensure Jamie is able to comprehend and implement appropriately (e.g., applied usually when they routinely takes their rapid- or short-acting insulin).
- Continue reinforcement on the basics of pattern management and CHO counting.

4b. To construct an insulin algorithm for Jamie, first calculate the ISF.

ISF Formula: $\frac{100}{59} = 1.69 \text{ mmol/L (2 mmol/L)}$

- Therefore, Jamie’s ISF is 1 unit rapid-acting insulin to lower the BG by 2 mmol/L. Jamie’s algorithm would require modification/adjustment based on his SMBG results.
- Construct the algorithm conservatively (i.e., err on the side of hyperglycemic initially).
- Remember that the lower the ISF number, the more insulin is given for a corrective dose. Jamie’s recent SMBG results revealed hypoglycemia once or more a day. Therefore, it is important not to be aggressive with corrective doses for hyperglycemia; hence the 3 mmol/L range algorithm (see below).
- The BG ranges in an algorithm do not have to match the ISF number.

Glucose	Bkfst	Lunch	Snack	Supper	hs bed
Less than 4.0	-1	-1		-1	
4.0-7.0 (Target)	RA 9 units	RA 8 units		RA 10 units	RA 2 units LA 30 units
7.1-10.0	+1	+1		+1	
10.1-13.0	+2	+2		+2	
13.1-16.0	+3	+3		+3	
16.1-19.0	+4	+4		+4	RA 2
Greater than 19	+5	+5		+5	RA 3

*Check ketones
& 3 a.m. BG check*

*Check ketones
& 3 a.m. BG check*

*Check ketones
& 3 a.m. BG check*

Case Study 2: Changing to Intensive Diabetes Therapy

Narrative

Joan is a 49-year-old teacher. They were diagnosed with type 2 diabetes 8 years ago; and at the time of diagnosis, was overweight and inactive. Joan was started on Metformin and attended Diabetes Centre self-management classes. They were determined to do well with their diabetes management. Joan has followed their meal plan and exercise program and has lost 10 lbs.

Two years ago, Joan's BG began to climb despite their efforts, and their A1C rose to 9.2%. Bedtime intermediate-acting insulin (NPH) was added. Recently, Joan noticed their BG levels rising again, and they have been feeling more tired than usual, especially after lunch and in the evenings. They are not really sure what their BG targets should be before aqua aerobics class but they feel that they could be better. Their next regular appointment at the DC is next week.

Physical and Laboratory Findings

- Present weight is 73 kg
- Most recent A1C is 8.0%
- Fasting BG is 10.2 mmol/L
- eGFR is 50

Current Diabetes Medication

- Glucophage® 1000 mg BID
- Trajenta® 5 mg once daily
- Novolin® NPH 45 units hs

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Feb. 20	8.9		11.5	9.8					IA 45 units	Aqua Aerobics 7 to 8 p.m.
Feb. 21	9.4	8.7	9.7						IA 45 units	
Feb. 22	10.1		10.3	7.8					IA 45 units	Aqua Aerobics 7 to 8 p.m.
Feb. 23	8.5	10.4		12.0					IA 45 units	

Case Study 2 Changing to Intensive Diabetes Therapy Questions

1. Using the information provided, what will you review with Joan when they come in for their appointment?
2. Why would introducing a basal-bolus regimen be appropriate and beneficial at this time?
3. What new information/skills would Joan need to know/learn to make the most of basal-bolus regimen?
4. Work out their starting M basal/bolus regimen doses, show calculations, and provide rationale for each. What about their present non-insulin therapy?
5. What recommendations would you give Joan as they begin their new basal/bolus regimen?

Case Study 2 Answer Sheet

1. At Joan's appointment, discuss the following:

- Recent lab and SMBG results and their symptoms of hyperglycemia.
- Discuss their targets for their BG values when they are physically active.
- Present meal plan and physical activity routine. Are there areas that need increased effort or fine-tuning?
- Natural progression of type 2 diabetes and the importance of adding multiple therapies early to prevent long-term complications.
- Concept of adding mealtime insulin and going to basal/bolus regimen and the rationale for more intensive diabetes therapy.
- Decreasing the Glucophage® because of their eGFR level but keeping the DPP-4 inhibitor as it is still indicated with an eGFR of 50.

2. Explain the following advantages of moving to basal-bolus regimen at this time:

- They are young and has demonstrated an interest in managing their diabetes as well as they can.
- They have the capacity and motivation to take responsibility for managing basal-bolus therapy well.
- They have a good medical plan (teacher).
- A basal-bolus regimen would give them more flexibility now and in the future.
- Increased energy.

3. Joan would require the following:

- Instruction in CHO counting and developing an insulin-to-CHO ratio.
- Information related to an basal-bolus regimen, mealtime insulin, etc.
- Increase in SMBG – adding 2 hour pc meal checks, at least initially and then periodically.
- A review of hypoglycemia – signs, symptoms, and treatment.
- Instruction to self-adjust insulin, starting with pattern management and eventually, variable dose scales.
- Check their eGFR levels again.

4. Starting Doses:

Step 1: Current TDD - 10 to 25% = new TDD 45 units - 10% (45 x 0.10 = 4.5) = 5 units
45 units - 5 units = new TDD (40 units)

Ten percent (10 %) reduction was chosen because SMBG and A1C are elevated, and they are symptomatic. Therefore, we do not want to reduce dose significantly.

Step 2: Basal requirement = 40 to 60% of the new TDD **40 units x 0.50 = 20 units**

Fifty percent (50%) was chosen, as it is a safe mid-range and a 50% split of basal/bolus doses is a reasonable starting point for basal-bolus therapy. Even though the morning BG values were consistently elevated, adding a rapid-acting insulin at supper should help lower their bedtime BG levels which will impact their breakfast BG levels.

Step 3: Bolus (meal) requirements = TDD - Basal dose **40 units - 20 units = 20 units**

15% TDD = 40 x 0.15 = 6 units ac breakfast

15% TDD = 40 x 0.15 = 6 units ac lunch

20% TDD = 40 x 0.20 = 8 units ac supper

NOTE: This was used to calculate meal doses because Joan is not presently CHO counting but does keep meal content quite consistent day to day.

Glucophage® still has a place in Joan's regimen as an insulin sensitizer and to promote less weight gain when combined with insulin. However, reduce to 500 mg BID because eGFR is 50.

Joan's new MDI regimen and starting insulin doses are:

<u>Breakfast</u>	<u>Lunch</u>	<u>Supper</u>	<u>Bedtime</u>
RA = 6 units	RA = 6 units	RA = 8 units	IA = 20 units
Glucophage® 500 mg		Glucophage® 500 mg	
Trajenta® 5 mg			

5. Recommendations include:

- Explain that this new insulin regimen should help to improve their overall BG control, but the insulin doses will need to be fine-tuned based on their SMBG results.
- Increase SMBG to ac and 2-hour pc meals and hs.
- Contact DC in 3 days for a review of BG levels and food intake by the diabetes HCT.
- Doses will be adjusted as necessary. Explain rationale to Joan and eventually have them suggest adjustments to increase self-management skills.
- Schedule a follow-up appointment for instruction on CHO counting.
- Keep present meal plan and activity level reasonably consistent until new doses are established and BG levels are within target. Later, discuss further changes such as increasing physical activity, insulin-to-CHO ratios, etc.
- Monitoring her eGFR as metformin is not used if renal decline progresses into lower ranges.

Insulin Dose Adjustment for Illness and Prevention/Treatment of DKA

Key Points

- The objective of sick day management in insulin-managed diabetes is to minimize metabolic imbalance, avoid severe hypoglycemia, and prevent hyperglycemia and ketosis leading to the development of diabetic ketoacidosis (DKA).
- DKA and Hyperosmolar hyperglycemic state (HHS) are diabetes emergencies with similar qualities.¹
- Illness and infection allow the body to release counterregulatory hormones that oppose the action of insulin. This allows the circulating levels of glucose to rise quickly along with an increase in circulating fat cells. With lower insulin levels, higher glucose levels, and increasing fat cells the blood becomes more acidic and ketone bodies increase.
- If unable to maintain adequate fluid intake or in the presence of an acute decline in renal function (due to vomiting/diarrhea or dehydration) clients should be instructed to hold specific medications which increase the risk for decline in kidney function (including SGLT-2 inhibitors) and/or have reduced clearance and increase risk for adverse effects (including metformin and sulfonylureas).¹
- Ketone testing is recommended for all people with type 1 diabetes during periods of acute illness accompanied by elevated BG, when preprandial BG levels remain elevated (greater than 14 mmol/L), or when symptoms of DKA such as nausea, vomiting, or abdominal pain are present. Ketone testing should also be considered in those with type 2 diabetes when the above conditions are present, as DKA can also occur in these Clients.^{1,2,3}
- Clients will vary in their ability to manage illness at home. Assessment of physical and cognitive abilities, as well as family support, is important before safely implementing home illness management. If the client has appropriate physical and cognitive abilities, illness management guidelines and insulin adjustment recommendations can be made over the phone by the diabetes educator (nurse or dietitian) certified in insulin dose adjustment.
- Insulin should **never be omitted** during sick days.
- Continue usual dose of intermediate- or long-acting insulin in most cases.
- Supplemental insulin (rapid- or short-acting) may be needed for hyperglycemia and ketosis. In general, ketones are markers of insulin deficiency and indicate the need for supplemental insulin. However, if BG remains elevated – with or without ketones – additional doses of insulin should be given. *See Table 2-1, page 29.*
- Supplemental rapid- or short-acting insulin can be safely given every three to four hours, without discussion with a physician.
- Usually, additional rapid- or short-acting insulin is required; however, in the face of hypoglycemia, a reduction in dose may be advised. *See Table 2-1, page 29.*
- BG and ketones should be monitored every two to four hours around the clock (including usual SMBG times, ac meals, and bedtime snack, even if not eating) as long as significant hyperglycemia and/or ketonuria/ketonemia persist.
- The usual target ranges for BG control may be relaxed during a brief illness. Often the goal of management will be to keep BG less than 14 mmol/L¹ and urinary ketones to negative (blood ketone 0.6 or less). *See Table 2-1, page 29.*
- If a client has difficulty eating solids during illness, 10 to 15 grams of carbohydrate (CHO) (liquid or soft foods) should be taken every one to two hours (to prevent starvation ketosis and hypoglycemia).
- Extra fluids (e.g., water, clear broth, sugar-free soft drinks, etc.) should be taken to prevent dehydration and facilitate excretion of

ketones in the urine. The body needs at least 2200 ml (9 cups) of fluid daily to prevent dehydration. As a rule of thumb, 250 ml (1 cup) an hour while awake can be recommended during times of illness.

- Communication with the physician, as well as the diabetes educator, is recommended when the client:
 - Is unable to tolerate fluids.
 - Has recurrent vomiting (more than once in four hours).
 - Has recurrent diarrhea (more than five times in one day).
 - Has taken extra insulin (two additional doses) as recommended, but hyperglycemia and ketones do not improve.
 - Has an illness that is very severe, worsens, or lasts longer than 12 to 24 hours.
 - Is unable to keep BG above 6 mmol/L.
 - Shows signs or symptoms of DKA, dehydration, or any other serious problem.
 - Has any questions/concerns about sick day management.
- The total daily dose (TDD) formula is used to decide how much extra insulin is needed in addition to usual dose. TDD equals the sum of all insulin taken each day. Supplemental insulin is calculated as a percentage of the TDD. *See Table 2.4 below.*
- Teach the client to calculate supplemental insulin dose increases by 10% and 15 of TDD and decreases in insulin doses by 10 to 30% of TDD.
- To prevent hypoglycemia, use caution when increasing insulin as illness resolves.

These are guidelines only; adjustments should be based on clinical assessment, individual response, and previous experience during sick days.

Table 2-4 Insulin Adjustment Guidelines for Sick Days

Use the chart below to find out how much extra rapid-acting insulin is needed based on the BG and ketone measurements.

Ketones		BG (mmol/L)	Extra Insulin Required (rapid-acting)
Blood	Urine		
		less than 6.0	Reduce usual dose 5 to 10%
les than 1.5	Negative/ Small	6 to 20	Usual doses and at usual times with corrections
1.5 to 3.0	Positive/ Moderate	greater than or equal to 14	10% of your TDD in addition to usual dose. If this doesn't work within 2 to 3 hours, try 10 - 15% of your TDD or, if on an insulin pump, use 1.5 times usual correction and seek medical attention.
less than 1.5	Negative/ Small	greater than or equal to 20	10% of your TDD in addition to usual dose. If this doesn't work within 2 to 3 hours, try 10 - 15% of your TDD or if on an insulin pump, use 1.5 times usual correction and seek medical attention.
greater than 3.0	Large	greater than 20	15% of your TDD in addition to usual dose and/or consult with your HCT. If not improving, seek medical help.

Adapted from: Diabetes Care Program of Nova Scotia. *Moving on...with Diabetes: A Youth in Transition Handbook*. Halifax, NS: Author; 2013.⁴

Example:

Kevin has been ill with the flu and has been testing his BG and urine for ketones every 4 hours. Kevin takes the following:

Before breakfast	Intermediate-acting insulin	30 units
	Short-acting insulin	10 units
Before supper	Short-acting insulin	8 units
At bedtime	Intermediate-acting insulin	20 units
		TDD 68 units

At supper today, his BG is 18.1 mmol/L and ketones in his urine are positive.

He would take an additional 10% of his TDD (units of his short-acting insulin in addition to usual supper dose).

10% of 68

= 0.10 x 68

= **6.8 (7 units)**

Kevin would take 15 units of short-acting insulin before supper. He should continue his BG and ketone testing every two to three hours and maintain increased fluid intake. The physician or diabetes educator should be notified of the situation.

Blood Ketone Testing

- Urine ketone test strips remain the most commonly used method for ketone testing. However, this method is prone to false-positive and false-negative results in certain circumstances and may provide a less accurate indication of ketoacidosis status.
- Blood 3 beta-hydroxybutyrate (3HB) measurements may have advantages over urine ketone testing in indicating the presence and severity of DKA. The reason is that 3HB may represent the largest portion of ketone production but is not measured in the urine.
- Blood 3HB reflects current ketonuria while urine lags behind because of what is left in the bladder from the last void therefore, ketones are detected in the blood earlier than in urine providing an early warning of impending DKA.^{1,2}
- The Precision Neo™ Blood Ketone Monitoring System (Abbott) measures 3HB levels on a finger stick blood specimen (1.5 uL) within 10 seconds with a detection range of 0 to 6.0 mmol/L. It uses a specific reagent strip for 3HB testing and another for glucose.

References

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2013;37(suppl 1):S1-S212.
2. Walsh J, Roberts R. *Pumping Insulin: Everything You Need for Success on an Insulin Pump + a new chapter on CGMs, 5th edition*. San Diego, CA: Torrey Pines Press; 2013.
3. Diabetes Care Program of Nova Scotia. *Moving on... with Diabetes: A Youth in Transition Handbook*. Halifax, N.S: Author; 2013

Recommended Reading

- Canadian Diabetes Association. *Building Competency in Diabetes Education: Advancing Practice, 3rd Edition*. Toronto, ON: Author; 2014.
- Canadian Diabetes Association. *Building Competency in Diabetes Education: The Essentials, 4th edition*. Toronto, ON: Author; 2013.
- International Society for Pediatric and Adolescent Diabetes (ISPAD). ISPAD Clinical Practice Consensus Guidelines 2014. *Pediatric Diabetes*. 2014;15(Suppl 20):Si-S290. Available at: <http://www.ispad.org/?page=ISPADClinicalPract>. Accessed December 2015.

Case Studies – Illness and Prevention/Treatment of DKA

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

Case Study 1: Illness

Narrative

Lilly is a 24-year-old child-care worker who was diagnosed with type 1 diabetes at age 20. They and their husband, Dave, moved into their new home just before Christmas. Lilly has been feeling exhausted and finding it difficult to control their BG over the last few days. They call this morning to cancel their appointment stating that they have been ill with the flu for the last two days and does not feel well enough to come in. They have had a slight temperature, is nauseated, and vomited once yesterday.

Physical and Laboratory Findings

- Present weight is 61 kg
- BMI is 23
- A1C is 8.0%

Current Diabetic Medication

- Rapid-acting (bolus) insulin 5 units ac breakfast
- Rapid-acting (bolus) insulin 5 units ac lunch
- Rapid-acting (bolus) insulin 6 units ac supper
- Long-acting (basal-24-h) insulin analogue 24 units ac bedtime snack

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst (ketones)	ac lunch (ketones)	ac supper (ketones)	hs bed (ketones)	Other	B	L	S	hs bed	
Day 1	13.4 (Negative)	12.2 (Negative)	18.5 (Positive)	21.2 (Negative)		RA 5 units	RA 5 units	RA 6 units	LA 24 units	Nauseated but not vomiting. Elevated BG and Ketones present
Day 2	12.1 (Negative)	19.8 (Positive)	16.3 (Positive)	17.2 (Positive)						Elevated BG and Ketones present
Day 3	15.1 (Negative)	17.7 (Negative)	12.9 (Negative)	13.5 (Negative)						Elevated BG and ketones present

Case Study 1 Illness Questions

1. What sick day guidelines would you review with Lilly?
2. When do you want Lilly to call you again?
3. How much extra insulin should Lilly have taken for each of their BG results?

Case Study 1 Answer Sheet

1. **Ask Lilly if they have been following sick day guidelines.**

- Monitoring and recording BG every two to four hours around the clock while elevated and/or until symptoms subside.
- Checking ketones every four hours.
- Taking their full dose of insulin. Ask if they have been taking extra insulin and ensure their calculations (based on the TDD rule) have been correct.
- Taking extra fluids to prevent dehydration and facilitate excretion of ketones (8 oz [250 ml] of calorie-free liquid every hour while awake). Ask about their food intake.

2. **You may want Lilly to call you at a specific time, or you may review the general rules that they should follow regarding communication on sick days. Contact the diabetes HCT when:**

- Vomiting more than once in four hours (or twice in one hour).
- Experiencing diarrhea more than five times in one day.
- There is persistent hyperglycemia without ketones.
- There is persistent hyperglycemia (greater than 17 mmol/L) and ketonuria/ketonemia in spite of extra insulin doses.
- There are signs and symptoms of DKA.
- Unable to eat or drink for more than four hours.
- Experiencing hypoglycemia.
- Illness lasts longer than 24 hours, is very severe, or worsens.
- Uncomfortable with sick day management guidelines and has questions or concerns.

3. **Lilly’s TDD is rapid-acting 5 units B +5 units L+ 6 units S + long-acting 24 units hs = TDD of 40 units; therefore, their extra doses would have been:**

breakfast	lunch	supper	hs bed	
13.4 (Negative) Usual 5 units	12.2 (Negative) Usual 5 units	18.5 (Positive) $6 + (10\% \text{ TDD}=4) =$ 10 units	21.2 (Negative) 10% TDD = 4 units	Check at 2400 & 0300 hours
12.1 (Negative) Usual 5 units	19.8 (Positive) $5 + (10\% \text{ TDD}=4) =$ 9 units	16.3 (Positive) $6 + (10\% \text{ TDD}=4) =$ 10 units	17.2 (Positive) 10% TDD = 4 units	
15.1 (Negative) Usual 5 units	17.7 (Negative) Usual 5 units	12.9 (Negative) Usual 6 units	13.5 (Negative) No extra insulin	

Case Study 2 Prevention/Treatment of DKA

Narrative

Jason is an 18-year-old, first-year university student living in residence. They are living away from home for the first time. They have met a few people on his floor who play the same online games as they do. Jason and a few of their friends agreed to play in an online tournament that will last all weekend. Their team's games are scheduled back to back on the first night. They played all night. They felt fine but missed their bedtime intermediate-acting (basal) insulin. They did not feel this was a problem, as it had happened in the past and they were ok. They checked their BG during the night and took some rapid-acting (bolus) insulin with a snack and slept for a while. The guys on the floor woke them at noon. Jason felt vaguely uncomfortable, stressed even, but thought it was likely nerves. They took a shower and had a bite to eat.

Their games are scheduled for the evening of the second day. They have to make frequent trips to the washroom and tries to stop drinking but can't. They blame their bathroom breaks for their inability to pick up their game. They did not play well. They have now missed two-night doses and one morning dose of their inter- mediate acting insulin.

It was after midnight when one of the guys said, "You're hyperventilating man! It's only a game." Jason knew something was wrong. Their BG was elevated. They did not have any ketone test strips, so they asked one of the guys to drive them to the ER. They were admitted to ICU for management of DKA.

Physical and Laboratory Findings

- Present weight is 70 kg
- BMI is 24
- Present BG is 30 mmol/L
- Blood ketones 3.0 mmol/L
- pH is 7.25
- A1C is 9.2%

Current Diabetes Medication

- Intermediate-acting (basal) insulin 18 units ac breakfast
- Rapid-acting (bolus) insulin 8 units ac breakfast
- Rapid-acting (bolus) insulin 8 units ac lunch
- Rapid-acting (bolus) insulin 10 units ac supper
- Intermediate-acting (basal) insulin 12 units ac bedtime snack

Case Study 2 Questions Prevention/Treatment of DKA

1. What were the precipitating factors causing Jason's DKA?
2. What were the signs and symptoms of impending DKA?
3. What would you suggest/review with Jason to prevent reoccurrence?

Case Study 2 Answer Sheet

1. The precipitating factors of Jason's DKA were:

- Missing his bedtime intermediate-acting insulin twice.
- Missing his morning intermediate-acting insulin.
- Inadequate insulin dosage is a major factor in approximately half the cases of DKA.
- Twelve (12) to 24 hours of insulin deficiency can cause profound fluid and electrolyte losses.
- Emotional stress - trying to win the game.
- Possible inadequate replacement dose even if they took all of their insulin dose.
- Disruption of usual routine or schedule may lead to insulin omission.

2. Signs and symptoms of DKA were:

- Elevated BG.
- Frequent trips to the bathroom (polyuria).
- Could not stop drinking (polydipsia).
- Hyperventilation.

3. Discussion should include:

- Review of present diabetes self-care practices and reinforcement of good diabetes self-management.
- Checking for ketones when BG is greater than 14.0 mmol/L.
- Importance of basal insulin.
- Strategies to help them remember to take their insulin even with busy university life.
- Guidelines for supplemental insulin/sick day management.
- When to call the diabetes HCT.
- Switching to long-acting insulin analogue once a day if they have been missing intermediate-acting insulin doses on a regular basis.

Insulin Adjustment for Physical Activity/Exercise

Key Points

- The benefits of exercise include reduced cardiovascular risk factors, increased sense of well-being, improved glycemic control, decreased insulin resistance, increased muscle strength/endurance, and promotion of weight loss/weight maintenance.¹⁻³
- Middle-aged and older Clients with diabetes who wish to undertake vigorous or prolonged exercise, should be assessed for conditions that may increase their risk for an adverse event.¹
- Before beginning an exercise program more vigorous than walking, people with diabetes should be medically assessed.¹ Caution is required for individuals with poor metabolic control. This includes, but is not limited to, recurrent hyperglycemia with ketosis or moderate to severe hypoglycemia.
- When starting moderate/vigorous or new activity, increased frequency of SMBG before, during, and after exercise is recommended to determine individual glucose response and to help make decisions about changes in CHO requirements or insulin dose.
- Exercise at consistent times of the day will facilitate insulin adjustments. If exercise is done on a regular basis, the TDD of insulin may need to be reduced.
- Hypoglycemia can occur during, immediately after, or many hours after increased physical activity or exercise. Overnight BG should be checked on several occasions to determine post-exercise insulin requirements.
- Clients who are less physically fit and start an activity/exercise program are more likely to have low BG and greater need to lower insulin doses.⁴
- Insulin should be injected into a non-exercising site prior to physical activity/exercise in order to decrease the risk of exercise-induced hypoglycemia.
- Exercise in the presence of too little insulin may increase already high levels of glucose and ketones and can precipitate diabetic ketoacidosis (DKA).
- Intense, short-duration anaerobic exercise may raise BG with the potential for hypoglycemia later. Correction boluses may be suggested after a short event of hyperglycemia. Glucose testing and record keeping will aid in this decision.^{4,5}
- Hypoglycemia can be prevented by decreasing the insulin that will be peaking during time of exercise; or extra CHO can be consumed before, during, or after exercise.¹
- Adjusting insulin for exercise versus adding CHO is encouraged for overweight clients. Some trial and error is necessary to find out what works best for each individual.
- Persons at risk for hypoglycemia (on insulin or specific non-insulin therapy) should always carry a source of CHO such as glucose tablets.
- Mild to moderate hypoglycemia should be treated by the oral ingestion of 15 grams of CHO, preferably as glucose or sucrose tablets or solution.¹
- Maintain hydration. It is important to drink plenty of fluids before, during and after exercise.

Physical activity is defined as any type of bodily movement.

It is typically unstructured and can take place in a variety of occupational, household, or leisure time situations (e.g., casual walking, gardening, household chores, etc.).²

Exercise is defined as planned, structured, physical activity, performed at a minimum level of intensity and duration with the objective of improving one's fitness (e.g., yoga, jogging, weight training, cross country skiing, etc.).²

Type 1 – Additional Key Points

By using record keeping that includes documentation of insulin doses, glucose results, CHO intake, and length and intensity of exercise; BG response to exercise can be identified and strategies for future exercise developed.

- In Clients with type 1 diabetes who are severely insulin deficient (e.g. due to insulin omission or illness), hyperglycemia can worsen with exercise.^{1,2,5,7}
 - In people with type 1 diabetes, if CBG is greater than 16.7 mmol/L and the person does not feel well, urine or blood ketones should be tested.
 - If ketone levels are elevated in the blood (greater than or equal to 1.5 mmol/L) or in the urine (2 + or greater than or equal to 4 mmol/L), it is suggested that vigorous exercise be postponed until insulin is given (with carbohydrate, if necessary) and ketones are no longer elevated.
 - If ketones are negative or “trace” and the person feels well, it is not necessary to defer exercise due to hyperglycemia, but caution is advised.¹
- Exercise performed late in the day or in the evening can be associated with increased risk of overnight hypoglycemia in people with type 1 diabetes. To reduce this risk, the bedtime intermediate or long-acting injected insulin dose, or overnight basal insulin infusion rate may be reduced by approximately 20% from bedtime to 0300 hours for CSII users.¹

Insulin adjustments for the high-performance, competitive athlete require advanced guidelines. These Clients should be referred to educators/specialists with an expertise in this area.

Type 2 – Additional Key Points

- The benefits of exercise for the person with type 2 diabetes are improved CHO metabolism and insulin sensitivity. The increased sensitivity may occur both during and up to 48 hours after exercise.^{7,8}
- Hypoglycemia in clients with type 2 diabetes using insulin therapy tends to be less problematic than in the individual with type 1 diabetes.¹
- Clients with type 2 diabetes generally do not need to postpone exercise because of high blood glucose, provided they feel well. If capillary blood glucose levels are elevated greater than 16.7 mmol/L, it is important to ensure proper hydration and monitor for signs and symptoms of dehydration, especially if performed in the heat.¹

Insulin Adjustment Guidelines for Aerobic Exercise (Type 1 And Type 2 Diabetes)

- Insulin adjustment for exercise is preferred to increasing CHO, as this may lead to weight gain.
- Insulin adjustment for exercise depends on intensity and duration of the exercise, circulating insulin levels during the time of exercise, type of insulin, and time lapsed since last injection.^{4,6}
- Clients with type 1 diabetes, reduce the bolus dose of insulin that is most active at the time of the exercise.¹
 - When activity follows soon after an injection of rapid- or short-acting insulin, a pre-exercise reduction of 20 to 50% for moderate activity and 50% for strenuous activity may be required.⁶
 - Prolonged exercise (around 3 hours or more) may require a reduction of up to 80%.⁶
 - Monitoring of BG before and after exercise should be used to determine the appropriate change the next time the exercise is done.⁶
 - If exercise occurs more than 3 hours after the pre-meal bolus of rapid-acting or short-acting insulin, a reduction in the bolus insulin dose may not be required.^{5,6}
 - If walking at a moderate pace (less than 4 mph for less than one hour) late in the afternoon, individuals taking intermediate-acting insulin (NPH) in the morning may require a 10 to 30% reduction of the morning NPH, as the activity is occurring during peak action of this insulin.⁸

- Insulin doses following prolonged exercise may need to be reduced; for example, the next meal dose may need a decrease of 20 to 50% and the bedtime basal dose by 10 to 30%.⁶

For information about exercise with pump therapy, see the Pump Therapy section, (Level 2-specialty).

Extra Carbohydrate (CHO) for Physical Activity/Exercise

- If glucose levels are less than 5.5 mmol/L, then 15 to 30 grams CHO should be ingested prior to starting the exercise.^{1,2}
- While insulin adjustment prior to exercise is generally preferred, not all exercise is planned, so additional CHO may be required. The amount of additional CHO required will be determined by BG results; timing and content of last meal; type of insulin and time of last injection; and type, duration, and intensity of exercise. E.g., moderate-intensity exercise such as swimming, tennis, and cycling may require 15 to 30 grams of CHO for every 30 to 60 minutes of exercise. High intensity activity, such as hockey, soccer and strenuous cycling, will require 30 to 60 grams of CHO every hour.⁹ See Table 2.5 page 89, for high and low glycemic index food choices for consumption before, during and after activity.
- It is not necessary to consume all the carbohydrates at once. It is better to divide the carbohydrates so something is being consumed every 20 minutes.⁹
- It is not always necessary to eat additional CHO for exercise. By using BG results, the need for additional CHO following exercise can be determined.⁶
- Exercise has several benefits for general health; however, people with diabetes must be aware of the possible risks. Monitoring BG levels before, during, and after exercise will allow the individual with diabetes to gain the knowledge necessary to make adjustments to insulin and CHO intake to exercise safely to their full potential.

Table 2.5: High and Low Glycemic Index Food Choices

High glycemic index food choices meet carbohydrate demands faster and may be useful to consume right before and during exercise.	Low glycemic index snacks 1 to 2 hours after activity can protect against delayed hypoglycemia.
The following examples of high glycemic index snacks contain 15 grams of carbs:	The following examples of low glycemic index snacks contain 15 grams of carbs:
<ul style="list-style-type: none"> • 7 plain soda crackers • 2 large or 12 small rice cakes • 1 low fibre granola bar 	<ul style="list-style-type: none"> • 7 plain soda crackers with cheese • ½ whole wheat peanut butter sandwich
Other examples of high glycemic index snacks include:	Other examples of low glycemic index snacks include:
<ul style="list-style-type: none"> • Diced fruit • Sports drinks/juice 	<ul style="list-style-type: none"> • A muffin with cheese • Fibre cereal sprinkled on yogurt

Source: Diabetes Care Program of Nova Scotia. Moving on...with Diabetes: A Youth in Transition Handbook. Halifax, NS: Author; 2013.

Example A (Exercise and a two injection/day regimen)

Mary has type 2 diabetes and attends an exercise class three times a week from 1000 to 1100 hours. Mary takes the following insulin doses:

Before breakfast	Intermediate-acting (basal) insulin	40 units
	Short-acting (bolus) insulin	12 units
Before bed	Intermediate-acting (basal) insulin	15 units

The insulin peaking during their exercise class is their short-acting insulin. Mary considers their exercise class to be of moderate intensity. Therefore, they would reduce their morning short-acting insulin by 20 to 50%.

20% of 12 units = 2.4 units OR **50% of 12 units = 6 units**
 (12 units – 2.4 units = 9.6 units or 10 units) (12 units – 6 units = 6 units)

Mary would take 40 units intermediate-acting insulin and 6 to 10 units short-acting insulin before breakfast on the mornings they exercise. SMBG results would help them fine-tune these adjustments.

Example B (Exercise and a four injection/day regimen)

John has type 1 diabetes and decides to go hiking this morning at 0900 hours. They will return by supertime (1700 hours). John takes the following insulin doses:

ac breakfast	Rapid-acting (bolus) insulin	8 units
ac lunch	Rapid-acting (bolus) insulin	6 units
ac supper	Rapid-acting (bolus) insulin	6 units
hs snack	Long-acting (basal) insulin	18 units

MDI regimens usually require reduction of rapid-acting insulin. In addition, because of the long duration of the hike, their long-acting insulin at bedtime on the day of the hike may also need to be reduced; they will need to figure that out with time.

Morning of hike: 50% of 8 units = 4 units (8 units - 4 units = 4 units)
John would take 4 units rapid-acting insulin before breakfast.

At lunch: 50% of 6 units = 3 units (6 units - 3 units = 3 units)
John would take 3 units rapid-acting insulin before lunch.

At supper: 50% of 6 units = 3 units (6 units - 3 units = 3 units)
John would take 3 units rapid-acting insulin before supper.

At bedtime: 20% of 18 units = 3.6 units (4 units) (18 units – 4 units = 14 units)
John may need to decrease to 14 units long-acting insulin at bedtime.

John should test BG more frequently over the next 6 to 15 hours (after the hike), as there may be delayed hypoglycemia. They should also test at 0300 hours the night after the hike if this is the first time they have hiked for a full day. If they experiences hypoglycemia through the night, next time they should decrease by a larger percentage (25 to 50%).

References

1. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2018;42(Suppl1):S1-S325.
2. Fowles J, Shields C, Murphy R, Durant M. *Building Competency in Diabetes Education: Physical Activity and Exercise* Toronto, ON: Canadian Diabetes Association; 2012.
3. American Diabetes Association. Standards of Medical Care in Diabetes-2019. *Diabetes Care*. 2019;42(suppl 1):S90-102.
4. Walsh J, Roberts R. *Pumping Insulin: Everything You Need for Success on an Insulin Pump + a new chapter on CGMs, 5th edition*. San Diego, CA: Torrey Pines Press; 2013.
5. Riddell MC, Perkins BA. Type 1 diabetes and vigorous exercise. *Canadian Journal of Diabetes*. 2006;30(1):63-71.
6. Diabetes Canada. *Building Competency in Diabetes Education: The Essentials 5th Edition*. Toronto, ON: Author; 2019.
7. Plotnikoff RC. Physical activity in the management of diabetes: Population based perspectives and strategies. *Canadian Journal of Diabetes*. 2006;30(1):52-62.
8. Strategies for Managing Special Situations in the Patient with Type 2 Diabetes, December 2007 Edition. Scherer Clinical Communication. Website: www.schererclin.com/documents/scherer_spec_sit_print.pdf. Accessed January 2020.
9. Diabetes Care Program of Nova Scotia. *Moving on... with Diabetes A Youth in Transition Handbook*. 2013. Halifax, NS: Author; 2013.

Recommended Readings

- Perkins BA, Riddell MC. Type 1 diabetes and exercise: using the insulin pump to maximum advantage. *Canadian Journal of Diabetes*. 2006;30(1):72-79.

Case Studies – Physical Activity/Exercise

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
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Case Study 1: Physical Activity/Exercise

Narrative

Joan is a 42-year-old woman who has had type 2 diabetes for 8 years. They were originally on non-insulin therapy but was started on insulin about a year ago. They have put on weight over the last year and has recently decided to start an exercise/physical activity program. They swim three (3) times a week from 1000 to 1100 hours. They have had a few low BG readings lately before lunch on these days, and they tell you that they think they will have to give up the swimming.

Physical and Laboratory Findings

- Present weight is 80 kg
- BMI is 30
- A1C is 8.5%

Current Diabetes Medication

- Intermediate-acting (basal) insulin 30 units and short-acting (bolus) insulin 10 units ac breakfast
- Short-acting (bolus) insulin 8 units ac supper
- Intermediate-acting (basal) insulin 10 units ac bedtime snack

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Sun.	8.6	13.7	8.8 (2-hour pc)			IA 30 units SA 10 units		SA 8 units	IA 10 units	
Mon.	9.0	3.5		8.5						Swimming 1000 to 1100 hrs.
Tues.	9.2	9.0	8.5							
Wed.	8.2	3.2	14.7							Swimming 1000 to 1100 hrs; overate at lunch.

Case Study 1 Physical Activity/Exercise Questions

1. What are some benefits of physical activity/exercise that you would discuss with Joan?
2. What about Joan's concern regarding hypoglycemia? How would you address this?
3. How much insulin should Joan take on the days they swim? Which insulin should be adjusted?
4. Before Joan goes swimming, their fasting BG is 12.6 mmol/L. What recommendations would you make?

Case Study Answer Sheet

1. The benefits of physical activity/exercise include:

- Improves glycemic control.
- Helps with weight loss.
- Helps reduce blood pressure.
- Decreases insulin resistance.

2. To address the problems of hypoglycemia, discussion would include:

- Benefits of swimming. Reassure them that the benefits outweigh the problems and that you will assist them in learning how to adjust their insulin to prevent the hypoglycemia.
- Insulin adjustments for exercise/physical activity for Joan.
- Encourage Joan to adjust their insulin versus adding food. As you want to encourage weight loss and improved glycemic control, it is better for Joan to adjust their insulin dose.
- Appropriate treatment of hypoglycemia. Stress the importance of having the necessary supplies within reach at all times.

3. Insulin adjustment

- It is their short-acting (breakfast) insulin that is peaking when they swim.
- They should decrease their short-acting (breakfast) insulin by 20 to 50% on days they swim.
- They have had two hypoglycemic episodes on swimming day. Recommend they start by reducing their short-acting insulin by 50% (5 units) ac breakfast on swimming days.
- If they continued to have hypoglycemia, they may need to reduce the breakfast intermediate-acting insulin as well.

4. Recommendations

- Do not make any additional changes other than those recommended above (reduction of short-acting insulin dose ac breakfast on swim days).
- Increase SMBG on swim days, both before and after swimming, as well as later in the day to check the results of the adjustment/exercise/physical activity. This would help them fine-tune the dose adjustments for subsequent exercise/physical activity.
- Tighter BG control should be addressed with them as they become less fearful of hypoglycemia. If their fasting BG is consistently above target, then bedtime intermediate-acting insulin should be increased.

Case Study 2: Physical Activity/ Exercise

Narrative

Bill is a 19-year-old man who has had type 1 diabetes for 7 years. On the weekend, they hike from 0900 to 1700 hours. They eat breakfast at 0630 hours.

Physical and Laboratory Findings

- Present weight is 84 kg
- BMI is 24
- A1C is 7.2%
- Fasting BG is 4.3 mmol/L

Current Diabetes Medication

- Rapid-acting (bolus) insulin 13 units ac breakfast
- Rapid-acting (bolus) insulin 10 units ac lunch
- Rapid-acting (bolus) insulin 15 units ac supper
- Long-acting (basal) insulin 25 units at bedtime snack

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Tues.	4.3	12.0	7.1	5.4		RA 13 units	RA 10 units	RA 15 units	LA 25 units	
Wed.	8.1	9.0	15.6	8.5						Afternoon meeting; extra food.
Thurs.	6.0	4.2	10.5	3.3						Jogging after supper.
Fri.	5.7	3.0	6.4	7.2						

Case Study 2 Physical Activity/Exercise Questions

1. What are the issues Bill would need to consider for their weekend hikes?
2. What insulin adjustments would you recommend Bill make on the days they hike?
3. Before Bill starts their hike at 0900 hours, their BG is 5.1 mmol/L. What should they do?
4. What should they do at noon?
5. Should they do anything in the afternoon?
6. Should they do anything else during the evening?

Case Study 2 Answer Sheet

1. Things to consider:

- Possible low BG during or after the hike, during the night following the hike, or even the following day.
- This is physical activity/exercise of long duration; therefore, Bill may need to make several adjustments to their insulin dose as well as carry extra food and supplies for preventing and/or treating low BG.
- If they hikes alone or with friends.
- Probably best to avoid injecting into their legs on day of the hike.
- Adequate fluid intake to avoid dehydration (carry enough).

2. Bill is on a MDI regimen and eats breakfast at 0630 hours. Recommendations include:

- Taking their usual breakfast dose as they are not going hiking until 0900 hours.
- Depending on SMBG results, reduce their lunch and supper doses by up to 50%.
- Depending on SMBG results and experience, reduce bedtime long-acting insulin (10 to 30%). Because of the long duration of the hike, there is potential for delayed hypoglycemia.
- Checking BG more often on the day of the hike would be advisable. Additional tests at 2300 and 0300 hours to determine his later response to the exercise.

3. Bill may need to eat 15 to 30 grams of CHO for every hour of exercise.

4. At noon, Bill should:

- Test their BG.
- Based on the BG readings, they may need to reduce their lunch insulin dose and/or eat extra CHO.

5. During the afternoon, Bill should:

- Test their BG.
- Based on the BG readings, eat extra CHO if less than 5.5 mmol/L.
- Ensure adequate fluid intake during hike.

6. In the evening, Bill should:

- Test their BG ac supper and ac bedtime. They may need to decrease rapid-acting insulin at supper or eat extra CHO.
- Bill may need to consider reducing their bedtime long-acting insulin even further than the calculation (previous page) because their SMBG readings ac breakfast are already very good.
- Check their BG at 0300 hours.
- Be alert to any hypoglycemia on the following day and reduce insulin if necessary, as they may have delayed hypoglycemia.

Insulin Adjustment for Travel

Key Points

- When travelling by car and long distances, the client needs to have ample supplies of medication and food. Blood glucose (BG) values should be assessed frequently when driving/travelling. Remember to pack enough food and hypoglycemia treatment for the trip, and keep these food supplies within reach at all times.
 - Land or sea travel usually allows the client to gradually adjust insulin/mealtimes to accommodate different time zones.
 - Air travel often results in multiple time zone changes in a brief period of time requiring adjustment to insulin doses/mealtimes.
 - There are several different formulas to use for adjusting insulin dose for time zone change.
 - Determine whether or not the destination observes daylight savings time. For example, Saskatchewan, Arizona, and Hawaii do not observe daylight savings time and, as a result, the time difference may not be as great.
 - The goal is to switch to the new time zone as soon as possible.
- If there is a disruption in the client's regular sleep pattern (circadian rhythm) there may be a change in BG results (insulin resistance increases).¹ Depending on the time zone changes, it may take a few days to adjust to the change; therefore, keep CHO ratios consistent to assist with insulin adjustments.
- Insulin adjustment for travel should be planned ahead, individualized, and as simple as possible.
- Frequent self-monitoring of BG (SMBG) is recommended while travelling to help detect/prevent problems. Check SMBG often and react accordingly.
- The lower the A1C, the greater the risk for hypoglycemia when making insulin adjustments for travel.
- If the A1C is higher and BG values are above target, there will be less of a chance of hypoglycemia with travel. Less than optimal control for a 24-hour period is acceptable, i.e., err on the side of hyperglycemia.
- North or south air travel usually involves minimal time difference and, therefore, requires no insulin dose adjustment to the intermediate-acting or long-acting insulin analogues.
- East or west air travel involving time zone differences of no more than three hours usually requires no insulin dose adjustment for the intermediate- and long-acting insulins. The client should be encouraged to spread meals and insulin as near as possible to normal.^{2,3}
- East or west air travel involving more than three time zones requires the preparation of meals and an insulin schedule. Each plan must be worked out individually.^{2,3}
- If long-acting insulin (42-hour) is being used as the only insulin (basal insulin), no insulin dose adjustments will be required if travelling. Note: There needs to be a minimum of eight hours between injections.²
 - When flying westward, hours will be gained, and the day will be longer with most likely an additional meal/food. As a result, blood glucose may be higher. If higher than normal readings, this short-term elevation is acceptable and expected. Advise more frequent testing and increased activity (if acceptable, to help manage higher blood glucose values).
 - When flying eastward, hours will be lost and the day will be shorter, but because of the long

Passengers with diabetes carrying insulin pens/ syringes and other diabetes-related materials are required to carry a doctor's letter describing the medications and medical devices in their possession. The letter and medications must be presented at security screening points.

half- life (around 25 hours) a reduction on the day of travel will have no/little impact. More frequent monitoring for hypoglycemia/changes in blood glucose is advised. Have snacks at the ready.

- It is important to gather the necessary information well in advance of the trip so that adjustment guidelines can be worked out, and a written copy of recommended adjustments for travel can be provided to the client.
- Snacks and sources of glucose should be with the traveller at all times.³
- Information helpful in developing a travel plan includes the following:^{3,4}
 - Flight times
 - When meals/snacks will occur
 - Number of hours gained or lost
 - Usual insulin dose/regimen
 - Usual meal/snack times
 - Logbook of recent BG readings
 - Flight connections; time between connections
 - Time of arrival at destination and planned activity or more activity than normal; i.e., sleep, meal, sightseeing, etc.
- The use of basal, long-acting insulin analogues has made crossing time zones less difficult. The injection time can remain on the same schedule as the individual's original time zone.³
- The mealtime bolus, rapid-acting insulin, can easily change to match the mealtime of the new destination.³ This is easier if the individual knows how to carb count.

Pump Considerations with Travel

- When individuals using an insulin pump arrive at their destination, they must change the time on the pump to correspond with the new time zone.³ They may need to adjust the timing of their nighttime basal rate based on when they sleep in the new time zone.³
- Clients can be reminded to change the time/clock on their pump as they travel across different time zones.
- In the case of a pump malfunction when travelling, it is important for Clients to obtain instruction regarding off-pump doses of injected insulin prior to travel and to carry their insulin, regimen, and supplies with them.⁴ Most companies will provide a loaner pump for travel as a backup. Call customer service to inquire at least one week in advance of travel.

Eastward Travel

- When flying east, the day will be shorter; therefore, less intermediate-acting insulin or long-acting insulin analogue will be required on the day of travel.^{2,4}
- When flying east, decrease the intermediate-acting insulin or long-acting insulin analogue by hours lost in the day.⁴

$$\text{Usual dose}^* - \frac{(\text{usual dose} \times \# \text{ hours lost})}{24} = \text{New dose}$$

*Usual dose of intermediate-acting insulin or long-acting insulin analogue.

If two injections of intermediate-acting insulin are taken per day, each dose of intermediate-acting insulin may need to be reduced for that day.

Eastward travel example:

John is travelling from Vancouver to Halifax (4-hour time difference). Their flight leaves at 0900 hours Vancouver time. John takes the following:

Morning	Intermediate-acting (basal) insulin	36 units
	Short-acting (bolus) insulin	8 units
Supper	Short-acting (bolus) insulin	6 units
Bedtime	Intermediate-acting (basal) insulin	20 units
		TDD 70 units

To determine the insulin adjustment for their travel day:

$$\text{Usual morning intermediate-acting insulin dose} - \frac{(\text{usual dose} \times \# \text{ hours lost})}{24} = \text{New dose}$$

$$36 - \frac{(36 \times 4)}{24} = 36 - 6 = 30 \text{ units}$$

John would take 30 units intermediate-acting insulin and 8 units short-acting insulin before breakfast on the day they fly from Vancouver to Halifax. They would take their usual supper dose, but the bedtime dose may need to be reduced depending on SMBG results. They would resume their usual morning dose the next morning.

Westward Travel – IF you gain more than 3 hours

- When travelling westward, the day will be longer and more intermediate-acting insulin or long-acting insulin analogue (24-hour) may be required with time zone differences of three or more hours.
- Depending on the flight schedule, duration, and time of arrival, an extra meal or snack may be part of the travel day.
- There are several different formulas to use for adjusting insulin dose for a westward time zone change.

Travel Plan A

- When flying west, increase the morning intermediate-acting insulin or the long-acting insulin analogue (24-hour) by the hours gained in the day by using the following formula:⁴

$$\text{Usual dose}^* + \frac{(\text{usual dose} \times \# \text{ hours gained})}{24} = \text{New dose}$$

*Usual dose of intermediate-acting insulin or long-acting insulin analogue.

OR

Travel Plan B

Usual morning or evening dose of intermediate-acting insulin or long-acting insulin analogue

- A catch-up dose of rapid- or short-acting insulin may also be required, depending on SMBG results and extra meals/snacks on the travel day.
- If the SMBG result is greater than 11 mmol/L, 10% of the total daily dose (TDD) as extra rapid- or short-acting insulin is taken prior to the extra meal.
- If the SMBG results less than 11 mmol/L, no extra insulin is taken.

OR

Travel Plan C

Usual morning or evening dose of intermediate-acting insulin or long-acting insulin analogue

- If carbohydrate (CHO) counting and an extra meal or snack is eaten on the travel day, an extra bolus is required.
- Use client's insulin-to-CHO ratio to determine the rapid- or short-acting insulin to cover the extra meal or snack.

Westward travel example:

John is planning to return to Vancouver. Their return flight from Halifax to Vancouver leaves at 1000 hours Halifax time. They arrive in Vancouver at 1630 hours. To determine the insulin adjustment for their travel day:

Using Travel Plan A

$$\text{Usual morning intermediate-acting insulin dose} + \frac{(\text{usual dose} \times \# \text{ hours gained})}{24} = \text{New dose}$$

$$36 + \frac{(36 \times 4)}{24} = 36 + 6 = 42 \text{ units}$$

John would take 42 units intermediate-acting insulin and 8 units short-acting insulin before breakfast on the morning of the flight to cover the longer day.

OR ALTERNATIVELY

John could take their usual morning doses and use Travel Plan B or C method.

References

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2. Diabetes Canada. Building Competency in Diabetes Education: The Essentials 5th Edition. Toronto, ON: Author; 2019. Childs B, Cypress M, Spollett G, eds. *Complete Nurses Guide to Diabetes Care*. Alexandria, VA: American Diabetes Association; 2005:70-71.
3. Canadian Diabetes Association. Building Competency in Diabetes Education: Advancing Practice, 3rd Edition. Toronto, ON: Author; 2014. Joslin Diabetes Center.
4. Saskatchewan Advanced Insulin Dose Adjustment Module - Insulin Dose Adjustment for Travel, November 2010. eHealth Saskatchewan. Website: <https://www.ehealthsask.ca/services/resources/Resources/advanced-insulin-dose-adjustment-module.pdf>. Accessed January 2020.

Recommended Reading

- Air Travel: General Travel Tips. Diabetes Canada. Website: <https://diabetes.ca/learn-about-diabetes/your-rights/air-travel> Accessed January 2020.
- Diabetes Travel Calculator. Sansum Diabetes Research Institute. Website: <https://diabetestravel.sansum.org/> Accessed January 2020.
- Travelling with diabetes. Diabetes Self-Management. Website: <https://www.diabetesselfmanagement.com/about-diabetes/general-diabetes-information/traveling-with-diabetes/> Updated November 2014. Accessed January 2020.

Case Studies – Travel

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

Case Study 1: Travel

Narrative

Tammy is a 21 year old who has had type 1 diabetes since age 8. They have been placed on rapid-acting (bolus) insulin and intermediate-acting (basal) insulin before breakfast; rapid-acting (bolus) insulin before lunch and supper; and intermediate-acting (basal) insulin at bedtime. They follow their 1800-calorie diabetes meal plan fairly well and has an A1C of 7.2%. They have been smoking half a package of cigarettes a day, and have made a considerable effort to quit by joining a support group. They recently had a job opportunity in Calgary, Alberta and came to the Diabetes Centre (DC) for advice about adjusting their insulin for travelling to Alberta. Tammy will leave the Sydney, Nova Scotia airport at 1100 hours and will arrive in Calgary at 1530 hours. There will be a meal available on the flight from Sydney to Toronto and again from Toronto to Calgary.

Physical and Laboratory Findings

- Present weight is 63.2 kg
- A1C is 7.2%
- Blood pressure is 120/70 mm/Hg
- Urine protein is negative
- TSH, cholesterol and kidney functions are in the recommended target range

Current Diabetes Medication

- Rapid-acting (bolus) insulin 10 units before (ac) breakfast
- Intermediate-acting (basal) insulin 36 units ac breakfast
- Rapid-acting (bolus) insulin 6 units ac lunch
- Rapid-acting (bolus) insulin 8 units ac supper
- Intermediate-acting (basal) insulin 26 units at bedtime

Recent SMBG Results

DATE	BLOOD GLUCOSE (BG)					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	Other	B	L	S	hs bed	
Jan. 19	4.0	10.0	8.0	7.0		IA 36 units RA 10 units	RA 6 units	RA 8 units	IA 26 units	
Jan. 20	9.0	7.0	5.0	12.0						Out for dinner
Jan. 21	6.0	11.5	9.5	5.0						
Jan. 22	12.0	7.0	5.0	8.0						

Case Study 1 Travel Questions

1. What information should Tammy bring with them to the DC about their planned trip?
2. What specific advice would you give them about their insulin adjustment when travelling to Calgary?
3. What general advice would you give them about travelling?
4. What would Tammy's insulin adjustment be if they decides to return from Calgary to Sydney?

Case Study 1 Answer Sheet

1. The information Tammy would need to bring to their appointment to help plan for their travel day would include:

- Flight times.
- When meals/snacks will occur.
- Number of hours gained or lost.
- Usual insulin dose/regimen.
- Usual meal/snack times.
- Plans for eating an extra meal or snack during their longer travel day.
- Flight connections; time between connections.
- Time sitting on a plane (i.e., consider what their normal daily activity is like.)
- Time of arrival at destination and planned activity; i.e., sleep, meal, sight seeing, etc. Do they plan to do an activity, other than the interview, that could impact their BG levels?
- Log book with recent BG results.

2. Flying westward: The day will be longer and more intermediate-acting insulin will be required.

Using Travel Plan A

- Increase morning intermediate-acting insulin by the hours-gained formula. Tammy will gain three hours flying to Calgary.
- Their usual morning dose is 36 units intermediate-acting insulin and 10 units rapid-acting insulin before breakfast.

$$\text{Intermediate-acting insulin dose} + \frac{(\text{usual dose} \times \# \text{ hours gained})}{24} = \text{New dose}$$

$$36 + \frac{(36 \times 3)}{24} = 36 + 4.5 = 40.5 = 40 \text{ units}$$

- Tammy would take 40 units intermediate-acting insulin and 10 units rapid-acting insulin before breakfast on the morning of their flight to cover the longer day (*see Travel Plan A*).
- Tammy would take their lunchtime dose to cover the meal provided during the Toronto to Calgary flight.
- Supper and evening doses could continue as usual on Calgary time.
- The next morning in Calgary their insulin dose would return to 36 units intermediate-acting insulin and 10 units rapid-acting insulin before breakfast.

3. General advice about travelling would include:

- Plan ahead for insulin adjustment when travelling.
- Try to obtain good glycemic control prior to travel.
- Keep your travel bag with you at all times. Put your diabetes supplies in your carry-on bag. They may want to have some extra supplies in a separate set of luggage.
- Carry plenty of food provisions in case of hypoglycemia or a delayed meal (e.g., dried or fresh fruit, juice, nuts, packets of peanut butter or cheese and crackers, etc.). Keep these within reach at all times.
- Always wear diabetes identification.
- If travelling over several time zones, the insulin dose may have to be adjusted during the time of actual travel. Therefore, travel plans should be discussed with the physician/diabetes health care team.
- Carry a letter from your physician describing your medical condition, medications, and necessary medical supplies. Having an extra prescription for supplies may be helpful.
- Ensure all medications have an identifying pharmacy label on them.
- Use an insulin storage container to protect insulin and test strips.
- Pack twice as many test strips and syringes or needle tips as well as twice as much insulin as needed. It might be a good suggestion to not pack all of their extra supplies together in case some luggage is lost.

4. If Tammy decided to return to Sydney, they would be flying eastward; the days are shorter.

- If Tammy decided to return home from Calgary and was still on the same insulin dose, they would take:

$$\text{Usual morning intermediate-acting insulin dose} - \frac{(\text{usual dose} \times \# \text{ hours lost})}{24} = \text{new dose}$$

$$36 - \frac{(36 \times 3)}{24} = 36 - 4.5 = 31.5 = 31 \text{ units}$$

- Tammy would take 31 units intermediate-acting insulin and 10 units rapid-acting insulin before breakfast on the day they fly home.
- They would take their usual supper insulin.
- Their bedtime dose of intermediate-acting insulin may also need to be reduced on the travel day depending on their SMBG results.
- They would resume their usual dose the next day.

Travel Plan

Tammy's Travel Plan – Sydney to Calgary

Usual Insulin Dosages: Bkfst: RA 10 units
Bkfst: IA 36 units

Lunch: RA 6 units

Supper: RA 8 units

hs: IA 26units

Date	Cities	Times	Suggested Insulin Dose	Comments
TRAVEL PLAN A				
Jan 24	Sydney (*ATZ)	0700 hours	IA 40 units RA 10 units	SMBG Take ac breakfast at home
		1100 hours		Depart Sydney to Toronto
		1130 hours	RA 6 units	SMBG Lunch on flight
	Toronto (*ETZ)	1220 hours		Arrive in Toronto
		1315 hours		Depart Toronto to Calgary
		1400 hours		SMBG Evening snack equivalent
	Calgary (*MTZ)	1520 hours (Calgary time)		Arrive in Calgary
		1700 hours	RA 8 units	SMBG – take catch-up dose if needed Supper
		2200 hours	IA 26 units	SMBG Bedtime snack
Jan 25	Calgary (*MTZ)	0700 hours (Calgary time)	IA 36 units RA 10 units	SMBG Resume usual doses

Adapted from: Calgary Regional Health Authority Diabetes Education Centres 2010

* VARIOUS TIME ZONES

ATZ= ATLANTIC TIME ZONE

ETZ= EASTERN TIME ZONE

MTZ= MOUNTAIN TIME ZONE

Case Study 2: Travel - Long-acting (42-hour) Insulin

Narrative

Sonny is a 65-year-old man with type 2 diabetes for 20 years. In the past, they did not adhere to their management plan and had sustained a myocardial infarction (MI) in 1998. Since then, they have been following their meal plan and has lost 30 lbs. They now keep regular appointments, walks after breakfast, and incorporates stress management practices into daily routine. They are on a combination non-insulin therapy (Glucophage® BID and Jardiance 25mg once daily) and long-acting 42-hour (basal) insulin once a day.. Their A1C is down from 9.5% to 8.3%. For their 40th wedding anniversary, they are taking their wife on a three-week trip to England and has come to the DC for assistance with insulin adjustment for the trip. The flight leaves Sydney, Nova Scotia at 1800 hours, Montreal at 2000 hours, and arrives in London at 0730 hours (0230 Montreal time). The return flight leaves London at 1515 hours and arrives in Montreal at 1810 hours (2310 hours London time), and Sydney, Nova Scotia at 0100 hours.

Physical and Laboratory Findings

- Present weight is 89 kg
- A1C is 8.3%
- Blood pressure is 140/86 mm/Hg
- eGFR is 52

Current Diabetes Medication

- Long-acting (42-hour)basal insulin 17 units ac breakfast
- Glucophage® 500 mg BID
- Jardiance 25 mg Breakfast

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Sept. 14	6.8	8.3	--	7.3		LA 17 units				
Sept. 15	6.0	--	8.3	--		LA 17 units				
Sept. 16	7.0	9.3	--	--		LA 17 units				
Sept. 17	--	10.2	--	9.4		LA 17 units				

Case Study 2 Travel Questions

1. What advice would you give Sonny about their diabetes management prior to advice about insulin adjustment during travel?
2. What advice would you give Sonny about travelling from Sydney to London?
3. What advice would you give them about their insulin for the return trip home?

Case Study 2 Answer Sheet

1. Sonny should be informed that:

- Review prevention and treatment of hypoglycemia. They will be doing extra walking in England while sightseeing and this may increase their chances of having a hypoglycemic event. Discuss extra exercise and insulin adjustments or extra snacks to prevent hypoglycemia.
- Ask him to check frequently to avoid hypoglycemia and hyperglycemia. If he is higher after the first day of travel than normal, he may need to do some extra activity.

2. **The flight from Sydney to Montreal (one hour time change) does not require a dose change, but a dose adjustment is required for the flight from Montreal to London (5 hours).**

Note: Remember to take into consideration extra exercise/activity and a change in their regular meal plan.

Flying eastward: When flying eastward, the day will be shorter. Sonny needs to make sure that there is more than eight hours between his long acting insulin dose injections. The time difference between Montreal and London is five hours. Sonny would possibly require less long-acting (24-hour) insulin at breakfast on the day they travel. but because his long-acting insulin lasts for 42-hours it is not recommended to lower his dose because of the half-life being so long (approximately 25 hours). Sonny should be advised to monitor for hypoglycemia and hyperglycemia and treat accordingly. If higher than normal readings, this short-term elevation is acceptable and expected. He could do some extra walking to help with BG values.

On the flight from Montreal to London, breakfast will be served at 0600 hours on the plane, and they will arrive in London at 0730 hours. They plan to do some sightseeing after checking into their hotel (i.e., extra walking); therefore, they would take their usual morning dose of long-acting insulin before breakfast on the plane. They would then change his clock to London time and resume his regular routine

3. **For the return flight, the time difference is five hours, and the day will be longer.** Sonny will leave London at 1515 hours and arrive in Montreal at 1810 hours (2310 London time) and in Sydney at 0100 hours. Supper will be served on the flight and Sonny will also have an extra meal after arriving in Montreal and before he flies to Sydney.

Sonny will continue to use his long-acting insulin at breakfast on his return trip and resume to Sydney time for breakfast that morning. Remind him to test more frequently as he may experience hyperglycemia with the extra hours and meal added to his day.

Case Study 3: Travel

Narrative

Adam is a 34-year-old computer programmer who was diagnosed with type 1 diabetes at the age of 12. They recently accepted a position as a data analyst with an engineering company in the United States. They are aware that their chosen career will require a lot of travel. They contacted the Diabetes Centre yesterday for advice on how to manage/adjust their insulin through the different time zones on his flight schedule. They state that they will be required to fly from Sydney, Nova Scotia to New York for a three-week training period and from New York to Honolulu for an indefinite period-of-time. They questioned whether their flight from Sydney to New York would require a major insulin adjustment and was concerned about insulin requirements for their flight from New York to Honolulu. Adam is aware that the flight from New York to Honolulu takes 11 hours and passes through several time zones. They informed us that Hawaii does not observe daylight savings time, so there is a time difference of 6 hours. The flight departs New York at 1000 hours. It arrives in Honolulu at 1500 hours Honolulu time, which is 2100 hours New York time.

Physical and Laboratory Findings

- Present weight is 78 kg
- A1C is 7.2%
- Blood pressure is 120/74

Current Diabetes Medication

- Rapid-acting insulin 10 units before meals
- Long-acting insulin 24 units at bedtime

Recent SMBG Results

DATE	BLOOD GLUCOSE				INSULIN				COMMENTS
	ac bkfst	ac noon	ac supper	hs bed	B	L	S	hs bed	
July 14	10.0	4.8	7.0	8.9	RA 10 units	RA 10 units	RA 10 units	LA 24 units	
July 15	6.0	7.8	11.2	7.0	RA 10 units	RA 10 units	RA 10 units	LA 24 units	
July 16	5.0	6.9	6.2	7.7	RA 10 units	RA 10 units	RA 10 units	LA 24 units	
July 17	7.0	9.0	9.7	17.2	RA 10 units	RA 10 units	RA 10 units	LA 24 units	Office party 1800 hours

Departure time: 1000 hours New York time; 0400 hours Honolulu time
Arrival time: 1500 hours Honolulu time; 2100 hours New York time

Case Study 3 Travel Questions

1. What specific advice would you give Adam about their insulin adjustment when travelling from Sydney to New York?
2. What specific advice would you give Adam about their insulin adjustment when travelling from New York to Honolulu?

Case Study 3 Answers

1. **North to south air travel involves a minimal time difference (one hour) and will require no insulin dose adjustment. It will be important ask about their plans for activity upon arrival at their destination. They have good control of their diabetes and they need to be aware of the risk for hypoglycaemia with added activity.**
2. **Adam will be travelling westward with a time zone difference of six hours (New York to Honolulu) and, therefore, an insulin dose adjustment will be required.**

- **Long-acting insulin dose adjustment:**

Since they are using long-acting insulin once a day, they should take his usual dose of long-acting insulin (24 units) the night before departure. Twenty-four hours later, which in their case would be just before landing in Honolulu, they can take half of his usual dose of long-acting insulin (12 units). That night at bedtime (Honolulu time), they can take the remaining half of their usual bedtime dose of long-acting insulin (12 units). The 24-hour long-acting insulin requirement would remain the same but splitting the dose helps them adjust to the change in time zones.

The following night in Honolulu they would continue their usual 24 units long-acting insulin at bedtime.

- **Rapid-acting insulin dose adjustment:**

Pre-meal rapid-acting insulin would remain the same as usual, and Adam could adjust the pre-meal, rapid-acting insulin dose as required during the travel day using the catch-up dose guidelines outlined in Travel Plan B.

- If they count carbohydrates, travel and adjustments will be easier.

Insulin Adjustment for Shift Work

Key Points

There is limited published evidence to guide shift work for Clients with diabetes using insulin therapy. This section reflects previous/older literature, supported by expert clinical judgement/guidance.

- Maintaining optimal glucose control while managing shift work requires planning because of changes to meal size/times, sleep, and activity patterns. Individual, flexible plans must be devised and adjusted based on self-monitoring of blood glucose (SMBG) results and personal experience. The aim is to match the action of insulin to the meals and activity on different shifts.¹ Clients working rotating shifts must be especially vigilant for hypoglycemia. An appointment with diabetes educators certified in insulin dose adjustment is important for developing a plan.
- Day to evening shifts are not usually a problem and no adjustment is needed other than timing of injections. On evening shift, people often get up later but eat three meals a day as usual. Insulin can be delayed up to one to two hours without significantly affecting BG control. All meals and insulin actions are delayed for the rest of the day.¹
- For clients who work frequent rotating shifts including nights, the night shift presents the most challenge. If the client is willing to monitor their BG frequently and learn how to adjust their short- or rapid-acting insulin for the size of the meal, a multiple daily injection (MDI) regimen or pump therapy offers the most flexibility.¹
- A once-a-day, long-acting insulin analogue given at the same time each day with rapid-acting insulin given before meals may create more stability with BG control.
- Long-acting insulin analogues, which release more slowly than intermediate-acting insulin and have little to no peak time action, can help prevent swings in BG that can happen during sleep as a result of the time-action of the intermediate-acting insulin.

It is important to stress that any plan must be individualized and adjusted as necessary.

Two (2) Injections/day regimen of intermediate-acting

Some clients do not want to inject or monitor their BG frequently and choose to continue with a twice/day regimen. For these clients, Belton and Carr¹ have developed a shift-work plan to accommodate both days at work and days off, which has worked well for them. This can be used as a starting point.

Morning Dose = B Evening Dose = hs

Work Shift	Morning	Evening
Days	B	hs
Evenings	B	hs*
Going on Nights	B	B
Nights	hs**	B
Going off Nights	hs***	hs

* If the supper break is early; i.e., 1630 or 1700 hours, the dose could be split: rapid-acting insulin at supper and intermediate-acting insulin at 2200 or 2300 hours, if client is willing.

** May need less insulin depending on how active the night shift is at work.

*** May need to reduce intermediate-acting dose if getting up at noon to start the day.

Example:

Morning dose = B 20 units		Evening dose = hs 30 units	
Work Shift	Morning		Evening
Days	B 20 units		hs 30 units
Evenings	B 20 units		hs* 30 units
Going on nights	B 20 units		B 20 units
Nights	hs** 30 units		B 20 units
Going off nights	hs*** 30 units		hs 20 units

* If the supper break is early; i.e., 1630 or 1700 hours, the dose could be split: rapid-acting insulin at supper and intermediate-acting insulin at 2200 or 2300 hours, if client is willing.

** May need less insulin depending on how active the night shift is at work.

*** May need to reduce intermediate-acting dose if getting up at noon to start the day.

Three to Five (3 to 5) injections/day regimen of rapid-acting and intermediate/long acting

- Basal/bolus regimens, especially four injections/day, offer the most flexibility for shift work.
- The morning and/or evening doses of intermediate-acting insulin can be switched for night shift.
- When transitioning off the night shift, the client may need to decrease the morning intermediate-acting dose if getting up at noon to avoid hypoglycemia.

Example using intermediate-acting and rapid-acting insulin:

IA = Intermediate-acting
 IA Breakfast = IA (B)
 IA Bedtime = IA (hs)

RA = Rapid-acting
 RA Breakfast = RA (B)
 RA Lunch = RA (L)
 RA Supper = RA (S)

Example: Day shift and evening shift:

0600	0700	0900	1200	1430	1730	1900	2200
Check BG IA (B) RA (B)	Shift starts	Check BG Break	Check BG RA (L)	Break	Check BG RA (S)	Off shift	Check BG IA (hs)

Example: Going on night shift

0800	1200	1500	1730	1900	0000	0300	0800
Check BG IA (B) RA (B)	Check BG RA (L)	Sleep	Check BG RA (S)	Shift starts	Check BG IA (B) Meal RA	Check BG Snack	Check BG IA (hs)* RA (B)

Example: Night shift

0800	1200	1500	1730	1900	0000	0300	0800
Check BG IA (hs)* RA (B)	Sleep	Check BG RA (L)	Check BG Snack	Shift starts	Check BG IA (B) Meal RA (S)	Check BG Snack	Check BG IA (hs) RA (B)

Example: Going off night shift

0800	1200	1400	1730	1930	2200
Check BG IA (B)* RA (B)	Check BG Get Up RA (L)	Check BG	Check BG RA (S)	Check BG	Check BG IA (hs)

	Breakfast	Noon	Supper	hs	0300 hours
Days	RA & IA	RA	RA	IA	
Evenings	RA & IA	RA	RA	IA	
*Going on Nights	RA & IA	RA	RA	IA	
*Nights	± RA & IA	RA	RA	± RA&IA	(RA if there is a meal)
*Going off Nights	± RA & IA	RA	RA	IA	

Example using long-acting and rapid-acting insulin:

LA = Long-acting

RA = Rapid-acting

	Breakfast	Noon	Supper	hs	0300 hours
Days	RA	RA	RA	LA**	
Evenings	RA	RA	RA	LA**	
*Nights	± RA		RA	LA** (± RA)	RA
*Going on Nights	RA	RA	RA	LA** (± RA)	RA
*Going off Nights	±RA	RA	RA	LA**	

Example of days, evenings and nights with rapid-acting and long-acting insulin analogue:

0800	1200	1500	1730	1900	0000	0300	0800
Check BG RA (B)	Check BG RA (L)		Check BG RA (S)		Check BG LA ** Meal RA	Check BG	Check BG RA (B)

* It may be necessary to have a smaller amount of long-acting insulin on the days the person is sleeping.

* When going on or off nights, the use of rapid-acting insulin is optional, depending upon SMBG results and if/when the person is eating a meal.

** Long-acting insulin may be taken at supper or bedtime. Although there can be flexibility in time of once daily dose, it is important to ensure consistency in time of dose.

References

1. Belton A, Carr D. Shifty business. *Diabetes Dialogue*. 2000;47(2):6-16.

Recommended Reading

- Saskatchewan Advanced Insulin Dose Adjustment Module - Insulin Dose Adjustment for Shift Work, November 2010. eHealth Saskatchewan. Website: <https://www.ehealthsask.ca/services/resources/Resources/advanced-insulin-dose-adjustment-module.pdf>. Accessed January 2020.

Case Studies – Shift Work

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

Case Study 1: Shift Work

Narrative

Sam is a 56-year-old man with type 1 diabetes. They work rotating 12-hour shifts at the local paper mill. They count carbohydrates (CHO). Their activity at work varies - sometimes it is quiet, and other times it is very busy. They count their CHO based on a meal plan to accommodate their night shift, day shift, and days off but now also wants to know how to adjust their insulin for t various shifts.

Physical and Laboratory Findings

- Present weight is 92.8 kg
- BMI is 29.5
- A1C is 7.8%

Current Diabetes Medication

- Rapid-acting (bolus) insulin 4 units ac breakfast; 6 units ac lunch; 6 units ac supper
- Long-acting (basal) insulin analogue 32 units at bed

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Sept. 20	8.0	6.3	7.2	7.6		RA 4 units	RA 6 units	RA 6 units	LA 32 units	Day shift.
Sept. 21	7.8	6.9	8.2	9.4		RA 4 units	RA 6 units	RA 6 units	LA 32 units	Day shift.
Sept. 22	8.2	5.4	6.1	5.2		RA 4 units	RA 6 units	RA 6 units	LA 32 units	Day off (splitting wood after supper).
Sept. 23	8.6	4.2	7.3	6.2		RA 4 units	RA 6 units	RA 6 units	LA 32 units	Day off.

Case Study 1 Shift Work Questions

1. What information do you need to know about their work schedule?
2. What are your concerns regarding safety issues when Sam is at work?
3. What recommendations would you make around safety issues?
4. Why are rapid-acting and long-acting insulin a good choice for shift work?
5. Develop a plan for their insulin doses/times for each of their shifts.

Case Study 1 Answer Sheet

1. You would need to know the following:

- Work schedule (two day shifts, two night shifts, four days off).
- Meal plan for days, nights, and transition days and accuracy of his CHO counting.
- Routine at home for various shifts.
- SMBG at home and at work.
- Overtime work or call-in.

2. Safety concerns could be:

- Factory work (machinery).
- Potential hypoglycemia from increased activity if there is no time to eat when shift gets very busy.
- Availability of glucose and food supply. How far is the lunchroom? Do they carry a fast-acting glucose supply at all times?
- Do they work alone or with other people?

3. Recommendations and discussion of the following will address safety issues:

- Supplies for treating hypoglycemia at work.
- Information for co-workers (teach others how to help if needed).
- Diabetes identification.
- Delayed hypoglycemia from increased activity.
- Importance of SMBG, specifically CGM (rt or is).
- Adjustment of insulin for increased activity.
- Glucagon administration (Is there a co-worker they could tell?)

4. Sam's insulin regimen

- With the use of rapid-acting insulin before meals, there is less chance of hypoglycemia because of the shorter duration of action. It also makes it easier to adjust insulin. Review Sam's insulin-to-CHO ratios, (15 grams CHO to be used with breakfast, lunch, and supper). Schedule a follow-up visit to adjust ratios as necessary. Ask Sam to provide two-hour postprandial BG readings to help guide these changes. At the follow-up visit, they could also be given an algorithm to correct readings that fall out of range.
- There is up to 24-hour basal coverage and virtually no peak with long-acting insulin, but if there is a significant increase in physical activity on some shifts, they need to be more vigilant for the possibility of hypoglycemia and delayed hypoglycemia.

5. Plan for Sam's insulin dose adjustment with various work schedules:

Work schedule:

Day shift (starts work at 0700 hours):

0600	1000	1200	1630	1800	2200
Check BG	Check BG	Check BG	Check BG	Check BG	Check BG
Breakfast	Snack	Lunch	Snack	Supper	Snack
RA 1 unit: 15 grams CHO		RA 1unit: 15 grams CHO		RA 1 unit: 15 grams CHO	LA 32 units

0630 Breakfast	1000 AM Snack	1200 Lunch	1430 PM Snack	1800 Supper	2200 Bedtime Snack
RA 1 unit: 15 grams CHO		RA 1 unit: 15 grams CHO		RA 1 unit: 15 grams CHO	LA 32 units

Days off are the same as day shift except that breakfast is later (0730 to 0830 hours).

Night shift (going to nights - starts work at 1900 hours):

0800 Breakfast	1500 Snack	1700 Lunch	2200 Snack	0100 Supper	0330 Snack
RA 1 unit: 15 grams CHO*		RA 1 unit: 15 grams CHO	LA 32 units	RA 1 unit: 15 grams CHO	± RA with a snack

*Sam eats breakfast before sleeping. They sleep 0800 to 1500 hours.

Case Study 2: Shift Work

Narrative

Tom is a 31-year-old shift worker with type 2 diabetes. He works rotating eight-hour shifts at the local plant. They are married with two young, school-aged children. His wife is supportive and wants to help them with his diabetes management. They had a session with the dietitian who worked out the amount of CHO to have at each meal to accommodate his various shifts. His activity at work is usually consistent. They are concerned that his weight is increasing. He used to be more active playing team sports, such as hockey, but is now too busy with work and the children's activities. They are also afraid of experiencing hypoglycemia at work or when they are sleeping. They are not adjusting his insulin.

Physical and Laboratory Findings

- Present weight is 90.6 kg
- BMI is 28
- A1C is 8.2%

Current Diabetes Medication

- Short-acting (bolus) insulin 10 units ac breakfast
- Short-acting (bolus) insulin 12 units ac lunch
- Short-acting (bolus) insulin 14 units ac supper
- Intermediate-acting (basal) insulin 20 units at breakfast
- Intermediate-acting (basal) insulin 30 units at bed

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
Day 1	8.1	5.2	6.3	7.2		SA 10 units IA 20 units	SA 12 units	SA 14 units	IA 30 units	Day shift 0730-1530
Day 2	9.2	6.9	12.0	5.2		SA 10 units IA 20 units	SA 12 units	SA 14 units	IA 30 units	Day shift 0730-1530
Day 3	8.6	7.4	6.3	8.0		SA 10 units IA 20 units	SA 12 units	SA 14 units	IA 30 units	Evening shift 1530-2330
Day 4	10.4	10.1	13.4	11.4		SA 10 units IA 20 units	SA 12 units	SA 14 units	IA 30 units	Evening 1530-2330

Case Study 2 Shift Work Questions

1. What areas of concern would you identify with Tom when discussing their diabetes management?
2. How would you help them with their fear of hypoglycemia? What strategies would you recommend to help them feel safe?
3. When Tom is ready, what would you discuss and teach regarding adjusting their insulin? Why would this be important for Tom?
4. Develop a plan for Tom's insulin doses/times for each of their shifts, including transition days. What things would you need to know?
5. Would a change to rapid-acting insulin and long-acting insulin analogue work as well? What would be the advantages?

Case Study Answer Sheet

1. The following should be discussed with Tom:

- Improved overall control as determined by SMBG and A1C.
- Fear of hypoglycemia.
- Weight gain and desirable BMI.

2. Discussion of the following should start towards addressing his fears about hypoglycemia:

- Meals – importance of spacing and CHO content.
- Advantages of learning to adjust insulin to prevent hypoglycemia versus extra food, which would contribute to weight gain.
- SMBG – importance of frequent testing ac and two-hour pc meals; before, during, and after activity/ exercise; before going to sleep.
- Informing friends, family, and coworkers of how to help with lows if needed.
- Availability of fast-acting glucose supply at all times (at work and at bedside).
- Glucagon administration (review with wife).

3. Discuss/review the following in regards to insulin dose adjustment:

- Insulin action, peak times, and site rotation. Injecting over exercising muscles.
- Importance of SMBG ac and two-hours pc meals, record keeping, and observing patterns.
- Setting target goals.
- Problem solving - using his SMBG results. (Provide an algorithm to give direction; then help them fine-tune).
- Importance of self-adjustment for tighter control and safety.
- Aiming for decreased A1C (approximately 7.0%).

4. Information needed to develop a plan for Tom would include:

- Their work schedule and meal plan/times for each shift.
- Activity levels for each shift, e.g., when on evenings, do they sleep later; when on nights, do they eat before going to sleep; how long do they sleep?

- Activity/meals on transition days, SMBG frequency, and willingness to test at work.
- Are they interested in learning to count CHO?
- Making sure they have written instructions to follow and arrangements for follow-up for revisions as necessary.
- Their interest/willingness to switch to a long-acting insulin analogue and rapid-acting insulin at mealtimes. If this is not an option, they may need to reduce their IA insulin when they are working night shifts.

5. **Rapid-acting insulin would work very well because of the shorter duration of action.** There would be less worry about hypoglycemia if Tom were able to learn how to adjust for decreased food intake or increased activity. Using a long-acting insulin analogue could help alleviate Tom’s fear of hypoglycemia while sleeping. Prior to walking or driving home, Tom should check their BG and eat a snack before leaving work if indicated.

Tom’s shift work schedule and dose adjustments for each shift:

Day shift (0730 to 1530 hours):

0630 Breakfast	0930 Snack	1200 Lunch	1500 Snack	1800 Supper	2300 Snack
SA 10 units IA 20 units		SA 12 units		SA 14 units	IA 30 units

Evening shift (1530 to 2330 hours):

0800 Breakfast	1000 Snack	1200 - 1300 Lunch	1500 Snack	1830 Supper	Midnight Snack
SA 10 units IA 20 units		SA 12 units		SA 14 units	IA 30 units

Transition day (going on nights, usually naps 1800 to 2100 hours):

0800 Breakfast	1000 Snack	1200 Lunch	1500 Snack	1700 Supper	2300 Snack
SA 10 units IA 20 units		SA 12 units		SA 14 units	IA 20 units*

* May need to be reduced depending on SMBG results and anticipated activity level during night shift. If they eat a meal during their night shift they may need some SA to cover the meal.

Night shift (2330 to 0730 hours) – usually sleeps 0800 to 1500 hours:

0800 Breakfast	1500 Snack	1700 Lunch	2200 Supper	0100 Snack	0300 Snack
IA 30 units		SA 12 units	SA 14 units IA 20 units		+ SA 8 to 10 units

* May require smaller dose or no short-acting insulin if BG is low or within target. Night shift short-acting insulin may need to be adjusted according to SMBG results and CHO content of meals/snacks or activity level. Be careful about insulin dose before going to bed.

Transition day (going off nights, usually sleeps 0800 to 1200 hours):

0800 Breakfast	1200 - 1400 Lunch	1600 Snack	1800 Supper	2300 Snack
+SA 10 units* IA 20 units	SA 12 units		SA 14 units	IA 30 units

* Many people like to get up at noon and start their day. Be especially vigilant for hypoglycemia on transition days.

SECTION 3

Specialty Areas

Insulin Dose Adjustment for Pregnancy

Key Points

- Diabetes mellitus during pregnancy can have a significant effect on maternal and fetal health. Optimal blood glucose (BG) control reduces the risk of diabetes-related complications in pregnancy.¹⁻³
- Ideally, women with pre-existing* diabetes should strive for optimal glycemic control prior to attempting to conceive. Optimal control is defined as A1C less than 7%.¹⁻³
- Most women with pre-existing type 2 diabetes should stop non-insulin therapy** and be started on insulin pre-conceptually.¹⁻² While known to cross the placenta, metformin has been shown to be safe for use in the presence of type 2 diabetes and polycystic ovary syndrome (PCOS) for ovulation induction.¹ Also, the continued use of metformin and/or glyburide until insulin can be initiated has been recommended to prevent severe hyperglycemia, which is known to be teratogenic.¹⁻³
- Hypoglycemia is more common during pregnancy due to the level of glycemic control recommended for optimal pregnancy outcomes as well as the blunting of counter-regulatory hormone response.¹⁻³
- Women should be educated about hypoglycemia unawareness and asymptomatic nocturnal hypoglycemia.¹⁻³
- Insulin adjustments are guided by regular meal/snack times; consistency in CHO (timing and amounts); routine/regular physical activity/exercise; and self-monitoring of blood glucose (SMBG).
- Frequent SMBG (4 to 8 times a day) is essential to identify glycemic patterns to guide treatments and to prevent or reduce occurrences of hypoglycemia.¹⁻³ Clients should be advised about the proper treatment of hypoglycemia and to carry a source of fast-acting glucose at all times.²
- Continuous glucose monitoring (CGM), or sensor-augmented therapy for pump users, may be useful to identify periods of glucose variability.¹
- Ketone testing in pregnancy is beneficial to rule out starvation ketosis in clients experiencing weight loss. Ketone testing may also be helpful during illness or periods of hyperglycemia.^{2,3}
- Diabetic Ketoacidosis (DKA) may develop at lower levels of hyperglycemia during pregnancy in women with pre-existing diabetes and is potentially fatal to the fetus.² Home ketone-testing methods using urine and blood are available.
- Ketone testing is recommended during illness or when BG exceeds levels of 14.0 mmol/L.
- Breastfeeding should be considered a form of physical activity and addressed accordingly. More frequent breastfeeding will lower BG and less frequent breastfeeding will cause BG to rise.

Not all women will be able to safely achieve optimal control; aim for the best possible control, while avoiding frequent or significant hypoglycemia.¹

***Pre-existing/pre-gestational** = The presence of diagnosed type 1 or type 2 diabetes prior to pregnancy.

****Non-insulin therapies** = oral antihyperglycemic agents or injectable incretin-based therapies.

Target Blood Glucose Levels for Pregnancy

- Target BG values for pre-conception planning and during pregnancy are lower than non-pregnant values.³

Table 3.1 Recommended Glycemic Targets Preconception and During Pregnancy^{1,3}

Pre-pregnancy A1C	< 7.0%
Fasting and preprandial plasma glucose (PG)	less than 5.3 mmol/L (3.8 – 5.2 mmol/L)
1-hour postprandial PG	less than 7.8 mmol/L (5.5 – 7.7 mmol/L)
2-hour postprandial PG	less than 6.7 mmol/L (5.0 – 6.6 mmol/L)

Self-Monitoring of Blood Glucose (SMBG)

- The frequency and timing of SMBG should be individualized – it is recommended at least four times a day for women taking insulin, planning a pregnancy, and during pregnancy. However, consideration should be given to cost, ability, glycemic control, etc.
- A combination of ac (before meal) and pc (after meal) SMBG is recommended. Evidence suggests that 1-hour postprandial tests are superior to 2-hour pc tests to reduce macrosomia and preeclampsia.¹⁻³
- Due to the increased risk of nocturnal hypoglycemia with any intensive insulin therapy, it is recommended that some overnight (0300 hours) tests also be included to assess for nocturnal hyperglycemia and hypoglycemia.¹
- Use of alternate sites for capillary SMBG is not recommended during pregnancy, as they might not identify the rapid change in glucose common during pregnancy.²⁻³

Achieving the glycemic goals of therapy during pregnancy is very important. Therefore, frequent insulin dose adjustment and close follow-up are recommended.

Insulin Therapy for Pregnancy

- Intensive insulin therapy is necessary to achieve optimal glucose control.
- The principles of insulin dose adjustment are used as outlined in the Pattern Management section on page 56.
- Initial insulin doses for pregnancy are determined according to individual glycemic assessment. Women with gestational diabetes mellitus (GDM) not well managed with nutrition and physical activity therapies should start with 6 to 10 units of basal insulin in early pregnancy (usually at bedtime). The starting dose will depend on the level of dysglycemia and current weight. Check BG, titrate, and introduce prandial (bolus) insulin as required.³
- It is common practice to switch women from long-acting insulin analogues to intermediate-acting (NPH→ or Humulin→ N) insulin for pregnancy.³ The decision as to which type of insulin is used should be made after a discussion regarding the benefits and risks of each insulin.
- Detemir appears safe for pregnancy use with similar perinatal outcomes as compared to NPH→ in pregnancy; however, the study was not powered to show differences in perinatal outcomes.¹ There is less data on use of glargine in pregnancy but no adverse effects have been found in fetal or maternal outcomes.¹
- Rapid-acting insulins (aspart and lispro) are safe for use in pregnancy¹⁻³ and may result in better postprandial control and fewer hypoglycemic episodes than short-acting insulins.^{1,2} To date, there is no information on the use of insulin analogue glulisine in pregnancy.¹
- Premixed insulin is not recommended during pregnancy, as it does not allow individual insulin dose adjustment as required.
- Insulin pump therapy may be useful in pregnancy due to the availability of multiple basal rates.¹⁻³ Women must be educated about the increased risk of hyperglycemia and DKA as they relate to technical issues such as pump failure, kinking of the infusion set, air bubbles, or prolonged use of an insertion site.¹⁻³ Insertion sites may need to be changed more frequently (e.g., every 2 days) due to the high doses infused. Hyperglycemia is more common as the site becomes less effective. Adjustments in pump settings are more aggressive than for non-pregnant clients.
- Insulin requirements can be anticipated to decline by 10 to 20% during the first trimester, leading to increased episodes of hypoglycemia especially in those women having optimal glucose control.³ Insulin requirements increase during the second and third trimesters to double or even triple the total needed prior to pregnancy, often peaking by 35 to 36 weeks gestation.^{2,3} Declining insulin requirements during the third trimester should not be interpreted as placental deterioration, but do indicate a need for close monitoring of fetal well-being.³
- There is a significant decrease in insulin requirements postpartum.^{2,3} Initial postpartum doses may be started at one-third to one-half pre-delivery doses.³
- Postpartum insulin requirements are often lower in women who breastfeed, and episodes of hypoglycemia are common. SMBG is used to guide management.^{2,3}
- Women with GDM requiring insulin during pregnancy rarely require insulin postpartum. SMBG should be used for 24 to 48 hours to help identify women with previously undiagnosed type 1 or 2 diabetes.³ It is recommended that testing for diabetes be done at approximately 6 weeks postpartum for those with GDM.

If the diabetes educator has limited or infrequent experience with pregnant women with type 1 diabetes, insulin requiring type 2 diabetes, or GDM, it is recommended that she/he be in contact with or mentored by a diabetes educator or physician with an expertise in this area.

Pattern Management

- The same principles for basic pattern management for dose adjustment are followed as for those of the non-pregnant adult.
 - Dose adjustments may need to be more aggressive and/or more frequent due to increased insulin resistance during pregnancy and need for tighter glucose control. Motivated women can be instructed to make insulin self-adjustments at home.^{2,3}
 - It is advised that adjustments be made according to pattern management rather than ongoing supplemental corrections to correct BG readings that fall out of range.^{2,3}
 - Daily adjustments may be necessary for persistent hyperglycemia.

Insulin Adjustment for Sick Days During Pregnancy

- First, rule out obstetrical complications as the cause of sick day symptoms:
 - Hyperemesis
 - Gestational hypertension
 - Urinary tract infection
 - Labour
 - Other potential medical conditions; e.g., appendicitis, renal colic, etc.
- The same principles of insulin adjustment for sick day management are followed as those for the non-pregnant adult with the exception that target BG levels remain tighter; i.e., less than 8 mmol/L even during sick days. See Section 2 - Insulin Adjustment for Illness and Prevention/Treatment of DKA, page 76.

*See the DCPNS
Pregnancy and
Diabetes Guidelines:
Approaches to
Practice 2014.³*

Other Situations

- Insulin adjustment for other situations - travel, exercise, and pump therapy - are the same as for the non-pregnant adult with the exception that BG target goals for pregnancy remain more stringent. For physical activity/exercise, see page 87; for travel, see page 96; and for pump therapy, see page 153.

Example

Audrey, age 31, Gravida 2 Para 1, was diagnosed with GDM at 26 weeks gestation. Her pre-pregnancy BMI is 29. They were started on a nutrition plan and taught SMBG. At the second appointment, her diet was appropriate; and they were walking 30 minutes daily after supper.

Her SMBG results were ranging:

ac breakfast	4.7 to 5.1 mmol/L
1-hour pc breakfast	7.0 to 7.6 mmol/L
ac supper	6.3 to 7.9 mmol/L
ac bedtime snack	5.9 to 6.9 mmol/L

They were instructed on insulin administration and prescribed intermediate-acting insulin 10 units ac breakfast.

	Day 1	Day 2
ac breakfast	4.8 mmol/L	5.1 mmol/L
1-hour pc breakfast	7.0 mmol/L	7.3 mmol/L
ac supper	5.6 mmol/L	5.7 mmol/L
ac bedtime snack	5.9 mmol/L	5.6 mmol/L

They were advised to increase her intermediate-acting insulin to 12 units ac breakfast to improve supper glucose levels.

	Day 1	Day 2
ac breakfast	4.8 mmol/L	4.9 mmol/L
1-hour pc breakfast	6.9 mmol/L	7.6 mmol/L
ac supper	5.2 mmol/L	4.8 mmol/L
ac bedtime snack	5.2 mmol/L	5.0 mmol/L

Audrey was advised to continue with her intermediate-acting insulin 12 units ac breakfast and to include SMBG ac and pc lunch and 1-hour pc supper. They were advised re: self-adjustment guidelines and given a follow-up appointment.

References

1. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Canadian Journal of Diabetes*. 2013;37(suppl 1):S1-212.
2. Kitzmiller J. *Managing Preexisting Diabetes and Pregnancy Technical Reviews and Consensus Recommendations for Care*. Alexandria, VA: American Diabetes Association; 2008.
3. Diabetes Care Program of Nova Scotia. *Pregnancy and Diabetes Guidelines: Approaches to Practice (2014)*. Halifax, NS: Author; 2014.

Recommended Reading

- The Canadian Forum for Injection Technique (FIT) Board. *FIT Forum for Injection Technique Canada: Recommendations for Best Practice in Injection Technique*. Canadian Diabetes Association, BD, and Diabetes Quebec; 2012. Available at: <https://www.bd.com/resource.aspx?IDX=25063>. Accessed December 2015.
- American Diabetes Association. Coustan D, ed. *Medical Management of Pregnancy Complicated by Diabetes, Fifth Edition*. Alexandria, VA: Author; 2013.

Case Studies - Pregnancy

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

Case Study 1: Pregnancy

Narrative

Mrs. M. is a 35-year-old, non-smoker who is pregnant. This is their first pregnancy. There is a family history of diabetes (grandfather with type 2 diabetes). They were referred to the DC at 30 weeks gestation with GDM and started on an 1800-calorie nutrition plan. They were also instructed on SMBG and asked to do SMBG ac and one-hour pc meals.

Based on their SMBG results ac supper, it was decided on November 12 that Mrs. M needed to start on 8 units of intermediate-acting insulin at breakfast. As values remained above target ac breakfast, 10 units of intermediate-acting insulin were added at bedtime on November 15.

Physical and Laboratory Findings

- 50 gram glucose challenge test result 10.8 mmol/L at 24 weeks gestation
- At 25 weeks gestation, sent for 75 g Oral Glucose Tolerance Test (OGTT). Positive diagnosis: fasting, 5.6 mmol/L; one-hour, 9.3 mmol/L; two-hour, 9.0 mmol/L
- Pre-pregnancy BMI = 32

Current Diabetes Medications

- Intermediate-acting insulin at breakfast and bedtime.

SMBG Results (after starting nutrition plan)

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	other	B	L	S	hs bed	
	1-hour pc		1-hour pc							
Nov. 10	5.1	5.2	6.6	5.6						
	7.1		8.4							
Nov. 11	5.3	4.6	5.8	5.3						
	7.1		7.9							
Nov. 12	5.5	4.7	6.1	5.5						
	8.2		8.3							
Nov. 13	5.4	5.4	5.6	5.4						Start intermediate-acting insulin 8 units ac breakfast
	7.3		8.6		IA 8 units					
Nov. 14	5.8	4.5	5.6	5.7						
	8.1		8.8		IA 8 units					
Nov. 15	5.9	5.0	5.5	5.5						Start intermediate-acting insulin 10 units at bedtime
	8.4		8.3		IA 8 units			IA 10 units		

Case Study 1 Pregnancy Questions

1. What are the indications for starting insulin in the pregnant population; and when initiating insulin, what time of day is best?
2. On November 15 follow-up, how would you advise them about the morning dose of insulin?
3. What would you advise about their fasting values?
4. How would you manage their high glucose values pc breakfast and supper?

Case Study 1 Answers

1. Consider that:

- Target BG levels for pregnancy are much lower than non-pregnant values (preprandial less than 5.3 mmol/L; 1 hour, less than 7.8 mmol/L; 2 hour, less than 6.7 mmol/L). Initiation of insulin is indicated based on BG values above target.
- When initiating insulin, the dose should be guided by the results of SMBG.
- In this case, the results are slightly higher ac supper than earlier in the day; therefore, insulin was started ac breakfast to affect the late afternoon/supper results.
- Once the supper results improved, insulin was added at bedtime to improve morning results.

2. As BG ac supper is still above target, advise them to increase their morning insulin by 2 units every one to two days until they have readings less than 5.3 mmol/L ac supper.

3. Consider the following:

- With an improvement in the ac supper values, add bedtime insulin to improve the fasting values.
- The bedtime insulin dose of 10 units is appropriate based on their degree of dysglycemia, weight, and response to the earlier insulin resistance.
- An alternative might be a small dose of rapid-acting (or short-acting) insulin ac supper and a small dose of intermediate-acting insulin at bedtime.
- As the pregnancy and insulin resistance progresses, increasing doses or adding a second dose can be done fairly aggressively.
- Waiting too long may cause a situation whereby you are always trying to “catch up.”
- Doses can be increased or added after a pattern of two to three days indicates the need.
- Remember long-acting insulin analogues are not routinely used in pregnancy.

4. Consider the following:

- Aim for BG readings ac breakfast and ac supper slightly lower into the target range (i.e., 4.0 to 5.0 mmol/L) to prevent or delay the need to add rapid-acting insulin.
- Inform Mrs. M. that the rapid-acting insulin may need to be added at a later date.
- A small dose (e.g., 2 to 4 units) of rapid-acting insulin can be added ac breakfast and ac supper.

Case Study 2: Pregnancy

Narrative

Mrs. B. is a 23-year-old woman who has had type 1 diabetes for six years. Mrs. B. was referred to the multidisciplinary team at the Pregnancy & Diabetes Clinic for pre-conception counseling. Mrs. B. would like to have children but has fears regarding miscarriage, fetal deformities, and the impact of pregnancy on their own health.

Physical and Laboratory Findings

- Height 5' 3"
- Present weight is 65 kg
- BMI is 26
- BP is 128/76 mm/Hg
- A1C is 8.6%
- No proteinuria; no neuropathy
- Annual eye exams show no retinopathy
- 2200-calorie nutrition plan
- No exercise/physical activity routine
- Smoker - 1 pack/day

Current Diabetes Medication

- Intermediate-acting (basal) insulin 15 units ac breakfast
- Short-acting (bolus) insulin 8 units ac breakfast
- Short-acting (bolus) insulin 8 units ac lunch
- Intermediate-acting (basal) insulin 8 units ac supper
- Short-acting (bolus) insulin 8 units ac supper

Recent SMBG Results

DATE	BLOOD GLUCOSE					INSULIN				COMMENTS
	ac breakfast	ac lunch	ac supper	hs bed	other	Breakfast	Lunch	Supper	hs bed	
June 4	10.7		2.9 (1500 hours)	9.6		IA 15 units SA 8 units	SA 8 units	IA 8 units SA 8 units		Same insulin daily
June 5	9.6	7.6	2.1 (1445 hours)	11.4						Over treated low, and ate more at supper
June 6	8.7	7.8	4.8	10.2						
June 7	11.2		1.9 (1515 hours)	9.4						

Case Study 2 Pregnancy Questions

1. What issues need to be addressed to improve Mrs. B's chances of a healthy pregnancy?
2. What issues need to be assessed to improve their glycemic control?
3. What might be some of the insulin adjustments that they can expect during their pregnancy?

Case Study 2 Answers

1. The issues that need to be considered for a healthy pregnancy include:

- Improve glycemic control to reduce the risk of fetal anomalies and miscarriage.
- Begin folic acid supplement.
- Prevent pregnancy until diabetes is better managed; ensure they are using reliable contraception. Preconception care and pregnancy planning are essential for improved maternal and fetal outcomes.
- Educate regarding pregnancy and diabetes.
- Smoking cessation.
- CHO counting.

2. Improved glycemic control would involve a discussion on the following:

- Nutrition Plan. A thorough review of their nutrition plan, consistency of carbohydrate intake, and carbohydrate counting instruction.
- Exercise/physical activity. Choose an activity that is enjoyable and suits their lifestyle.
- Insulin:
 - Adjustments are needed. The two areas that need immediate attention are mid-afternoon hypoglycemia and fasting hyperglycemia. Discuss adjustments to correct hypoglycemia first.
 - A: Introduce a four injections a day schedule and doses.
 - B: Reduce morning intermediate-acting insulin and
 - C: Change to rapid-acting insulin in place of short-acting insulin.
 - D: Move supper intermediate-acting insulin to bedtime.

B and C should reduce the mid-afternoon hypoglycemia; C should give them more flexibility; A and D should improve their fasting hyperglycemia; A to D should improve their A1C prior to conception. For example:

ac breakfast	ac lunch	ac supper	hs bed
IA 12 units RA 8 units	RA 6 units	RA 8 units	IA 8 units

- Teach insulin self-management and guide them as necessary.
- Review site rotation.
- Ensure appropriate treatment for hypoglycemia.
- Increase number of SMBG tests a day (ac and pc tid and ac and hs snack), and test at 0300 hours before adjusting bedtime intermediate-acting insulin.

3. Review the following expectations for pregnancy.

- Insulin requirements often are lower in the first trimester increasing the risk of hypoglycemia. Insulin doses would need to be lowered according to SMBG results.
- Insulin requirements may double or triple from pre-pregnant doses during the 2nd and 3rd trimester of pregnancy. Frequent SMBG and dose adjustment is crucial.
- Frequent contact is recommended (in person or by phone, e-mail, etc.) to assess progress and provide guidance and reassurance.

Case Study 3: Pregnancy

Narrative

Mrs. P. has type 2 diabetes and presents with an unplanned pregnancy. It is confirmed with an ultrasound that they have a viable pregnancy at 7 weeks gestation. They wish to continue the pregnancy.

Physical and Laboratory Findings

- Height 5' 4"
- No neuropathy; no retinopathy
- Present weight is 95 kg
- Present daily intake is around 2200 calories
- BMI is 36
- Attends water aerobics once a week
- BP is normal
- Non-smoker; no alcohol
- A1C is 9.6%

Current Diabetes Medication

- Janumet® 50/1000 mg BID

Recent SMBG Results

DATE	BLOOD GLUCOSE	
	ac breakfast	2-hour pc supper
Day 1	8.6	
Day 2	7.8	9.6
Day 3	9.1	11.3

Case Study 3 Pregnancy Questions

1. What issues need to be discussed regarding their glycemic control?
2. What issues need to be addressed regarding their diabetes medication?
3. What factors need to be considered when starting them on insulin?

Case Study 3 Answers

1. The following issues need to be discussed:

- Target glucose values for pregnancy are: ac meals less than 5.3 mmol/L; 1-hour pc meals less than 7.8 mmol/L; 2-hour pc meals less than 6.7 mmol/L in order to reduce the risk of miscarriage and fetal anomalies.
- One-hour pc testing is preferred over 2-hour pc testing. Attaining the 1-hr pc target of less than 7.8 mmol/L will help to reduce the risk of fetal macrosomia and the development of maternal gestational hypertension.
- SMBG should be increased; e.g., ac and 1-hour pc tid. There is need for increased BG testing in pregnancy; including more pc tests. This helps to identify patterns of BG (above or below target) thus allowing more timely intervention to achieve the required tight glycemic control required in pregnancy.
- Aggressive BG control may affect the presence of retinopathy. An eye exam is recommended. Screening for other microvascular complications is also recommended.

2. The following issues regarding their diabetes medication need to be addressed:

- Januvia→ (Sitagliptin) is not recommended in pregnancy– (*See Section 4, Table 4.2, page 174.*)
- Insulin therapy is required to improve their glycemic control for pregnancy. All recorded BG values are above the targets for pregnancy. These values indicate a need for intermediate-acting insulin at bedtime to reduce their fasting BG. The high values pc supper indicate a need for rapid- acting insulin at supper. Further testing is needed to assess their need for intermediate-acting insulin at breakfast and for rapid-acting insulin at breakfast and/or lunch.
- Glucophage® should be continued at 1000 mg bid until insulin initiation and glycemic targets achieved. Glucophage® has been shown to be safe in early pregnancy and will help to prevent severe hyperglycemia, which is teratogenic.

3. Consider the following:

- Nutrition plan adjustments
- Weekly water aerobics
- Increased BMI
- Significantly elevated glucose readings
- Stopping their non-insulin therapy
- Their understanding of the need for multiple daily injections as the pregnancy progresses
- Hypoglycemia at any point and the increased possibility as they near targets
- Frequent insulin adjustments
- Teaching insulin self-adjustments
- SMBG frequency will change. If on basal only insulin testing 2 times a day is recommended (alternate times, e.g., ac/pc B and S one day; ac/pc L and hs the next, etc. If moved to meal time insulin, will require ac/pc testing with all meals.
- They need an ophthalmology assessment as soon as possible given their unplanned pregnancy and anticipated aggressive glycemic improvement.
- Screening for other microvascular complications
- Close follow-up

Insulin Dose Adjustment for Children/Adolescents

Key Points

- Children and adolescents require sufficient insulin to support healthy growth and development and prevent long-term complications.
- Insulin is required for children with type 2 diabetes with severe metabolic decompensation at diagnosis (e.g., DKA, A1C greater than 9.0%, symptoms of severe hyperglycemia).¹
- Rapid-, short-, intermediate-, or long-acting insulins are appropriate for use in children and adolescents. Long-acting insulin analogues (basal insulin) are approved for clients older than 6 years of age but are used with physician prescription in children under 6 years of age.
- Insulin dosage should be individualized based on the child/adolescent's body weight and BG levels. The units of insulin/kg required in a 24-hour period should be monitored on a regular basis.²
- The starting dose of insulin is usually 0.5 to 0.6 units/kg of body weight/day, but must be individualized. During the first week of therapy, an average of 1 unit/kg of body weight/day may be required because the child/adolescent is initially insulin resistant.^{1,2}
- Insulin requirements may decrease to as little as 0.1 to 0.3 units/kg of body weight/day during the partial remission or honeymoon phase. Continuation of insulin (at a reduced dose) is recommended during this period.^{1,2}
- Any of the insulin regimens may be used, but the current recommendation is that a three or four injections a day regimen be the starting schedule for all children and adolescents with type 1 diabetes.
- The average dose of insulin required depends on the child/adolescent's activity and metabolic requirements; however, it is usually under 1 unit/kg of body weight/day in the prepubertal child.²
- During a teenage growth spurt, insulin requirements may reach 1.5 units/kg of body weight/day or more.²

Some young children may be quite sensitive to rapid-/short-acting insulin and require little or none at all.

Targets for Children/Adolescents with Type 1 Diabetes^{1,2}

The targets are intended as guidelines (Table 3-2). There is little scientific evidence for age-related glucose targets. Each child should have their targets individually determined with the goal of achieving a value as close to normal as possible while avoiding severe hypoglycemia, as well as frequent mild to moderate hypoglycemia.²

Table 3-2 Target Blood Glucose for Children/Adolescents with Type 1 Diabetes

Age Groups	A1C%	ac meals	2-hours pc meals
less than 18 years of age	less than 7.5%	4.0 to 8.0 mmol/L	5.0 to 10.0 mmol/L

Self-monitoring of Blood Glucose (SMBG)

- Routine SMBG ac meals and bedtime snack.
- When short-acting or rapid-acting analogue is used, postprandial (2-hour pc) BG monitoring will help fine-tune mealtime insulin dose or bolus (if on pump or MDI).
- Extra testing at 2300 and 0300 hours is recommended when first diagnosed. These tests may be discontinued once SMBG results are stable.
- 2300 and/or 0300 hour readings are indicated if:
 - There is a concern of possible nocturnal hypoglycemia.
 - At time of illness.
 - Evening insulin has been changed.
 - The child has had a more active day than usual and/or there is a history of post-exercise hypoglycemia.
 - There is persistent fasting hyperglycemia (rule out dawn phenomenon).
 - As necessary, as directed by the diabetes HCT or parental judgment.
- Continuous glucose monitoring (CGM), or sensor-augmented therapy for pump users, may be helpful to identify periods of glucose variability.¹
- There are stand-alone CGM units that can be used without pump therapy.

Pattern Management

- The same principles for basic pattern management for dose adjustment are followed for children and adolescents as those for adults.
- Assess patterns or trends of BG results over two to three days.
- Identify other factors that may cause BG variability, e.g., food intake, CHO counting skills, activity level, presence of illness/infection, etc., prior to making insulin dose adjustment.
- Identify insulin action that influences a particular pattern.
- Adjust insulin by 1 to 3 units (maximum 10% of time of day dose). For toddlers, the adjustment may be 0.5 units changes.¹
- Leave the changes for three to four days, then reassess.
- Hypoglycemia must be corrected more aggressively. The cause of hypoglycemia should be determined, and attempts made to prevent it if the cause is identified. This may include insulin dose adjustment.
- Severe hypoglycemia with loss of consciousness requires medical assessment and assistance with immediate insulin dose adjustment.
- All families and adolescents should be instructed in insulin dose adjustment. Assessment of readiness to assume responsibility for self-insulin dose adjustment is ongoing. A staged approach to transferring this responsibility from the HCT to the family works best. The child/adolescent/family should know that assistance is always available for situations in which they feel uncomfortable.¹

If the diabetes educator (nurse or dietitian) has limited and/or infrequent experience with diabetes in children, it is recommended that she/he be in contact with or mentored by a diabetes educator or MD with expertise in this area.

Supplemental Dose Adjustment

- Most children/adolescents should be provided with an individually designed variable dose algorithm to adjust rapid-acting insulin.
- The purpose of the algorithm is to provide guidelines for adjusting the dose of insulin based on BG level, food intake, and/or anticipated activity.
- The algorithm is developed by the diabetes HCT together with the child/adolescent/family and should be reassessed on a regular basis.
- Adjustments to the variable dose algorithm are very individualized.
- Adjust algorithm by 5% of the TDD if BG is 15 to 17 mmol/L or use ISF (Insulin Sensitivity Factor, Section 2 – Supplemental Dose Adjustment) to determine adjustment needed.
- Adjust algorithm by 10% of the TDD if BG is greater than 20 mmol/L or use the ISF to determine adjustment needed. Also, if moderate to large urine or blood ketones are present, follow management guidelines for sick days. (See Table 3-3 for sick day adjustments, page 140)¹

Use of algorithms for adjustments should be individualized depending on the regimen and motivation of the child/adolescent/family.

Sample Format for Algorithm

IA = Intermediate-acting

RA = Rapid-acting

LA = Long-acting

Circle appropriate Insulin(s)

BG (mmol/L)	Basal Insulin	Rapid/Short-Acting (Bolus Insulin)				Basal Insulin
		Breakfast	Lunch	Supper	hs/bed	
Less than or equal to Target	IA/LA (AM)	RA	RA	RA	RA*	IA/LA (Supper/hs)

*Use of rapid-acting insulin at bedtime is used cautiously because of the risk of nocturnal hypoglycemia. A conservative supplement for excessively elevated BG readings at bedtime is sometimes used. For children/adolescents on MDI, a conservative dose for the bedtime snack may be used.

Sick Day Management

- Acute illness usually upsets BG levels and increases insulin requirements; however, low BG levels (plus decreased insulin requirements) are also possible. Good judgment and close monitoring are required.²
- Illness can be managed at home if there is careful attention to sick day guidelines and DKA prevention, and 24-hour access to the diabetes HCT.
- BG and ketones should be tested every two to four hours while the child is sick.
- Supplemental rapid-/short-acting insulin may be given based on SMBG results and the presence or absence of urine or blood ketones. The use of rapid-acting insulin is advised. (See Table 3-3)
- Supplemental rapid-/short-acting insulin is calculated as a percentage of the TDD using the 5-10-15% rule.
- Take 10 to 15 grams CHO as liquid hourly if unable to eat solids.
- Take extra sugar-free fluids to prevent dehydration.
- Record BG and ketone results.
- Call diabetes HCT for assistance as needed.
- Medical assessment is required if the child/adolescent:
 - Has vomited more than once in four hours.
 - BG is less than 4 mmol/L and unable to keep BG above 4 mmol/L with hourly fluids and glucose tablets and decreased insulin.
 - There is no improvement in BG after two extra doses of insulin two hours apart and no improvement in ketones.
 - Is showing signs of DKA.

NOTE: Ketones may be elevated with normal or low BG as a normal response to low caloric intake during illness and do not require extra insulin.

Table 3-3 Insulin Adjustment Guidelines for Sick Days

Ketones		BG (mmol/L)	Extra Insulin Required (rapid-acting)
Blood	Urine		
		less than 6.0	Reduce usual dose 5 to 10%
less than 1.5	Negative/ Small	6 to 20	Usual doses and at usual times with corrections
1.5 to 3.0	Positive/ Moderate	greater than or equal to 14	10% of your TDD in addition to usual dose. If this doesn't work within 2 to 3 hours, try 10 - 15% of your TDD or, if on an insulin pump, use 1.5 times usual correction and seek medical attention.
less than 1.5	Negative / Small	greater than 20	10% of your TDD in addition to usual dose. If this doesn't work within 2 to 3 hours, try 10 - 15% of your TDD or if on an insulin pump, use 1.5 times usual correction and seek medical attention.
greater than 3.0	Positive/ Large	greater than 20	15% of your TDD in addition to usual dose and/or consult with your HCT. If not improving, seek medical help.

Source: Diabetes Care Program of Nova Scotia. *Moving on...with Diabetes: A Youth in Transition Handbook*. Halifax, NS: Author; 2013.

Exercise/Physical Activity

- All children should be involved in regular exercise/physical activity for good health.
- Increased frequency of SMBG before, during, and after exercise/physical activity is essential to determine individual response to exercise/physical activity.¹
- Exercise/physical activity may enhance the effect of exogenous insulin by increasing glucose uptake by muscle cells and intracellular glucose metabolism. Depletion of glycogen stores may occur with moderate to intense or prolonged exercise/physical activity.
- If excessive hyperglycemia is present, insulin levels may be too low; and glucose cannot be adequately utilized by the muscles. Also, with the rise of counter-regulatory hormones during exercise/physical activity, glucose and free fatty acid metabolism continue to increase plasma glucose and ketone levels. This can lead to progressive hyperglycemia and even ketosis.
- Exercise/physical activity should be avoided when BG is elevated (greater than 14 mmol/L) and ketones are present. Do not exercise with BG greater than 14 mmol/L and small ketones in urine or greater than 0.5 mmol/L in blood.²
- Young children often need extra food because activities are often unplanned.
- As activity becomes more organized/planned, adjusting insulin is preferred.
- Adjusting insulin (versus adding food) is recommended for adolescents (greater than 13 years) and younger children when possible.
- Hypoglycemia can be prevented by decreasing insulin dose or adding food.
- Always carry a source of fast-acting glucose when exercising; e.g., glucose tablets.²
- Glucose tablets are now the recommended treatment of hypoglycemia for children/adolescents able to use them (i.e., infants cannot).
- Hypoglycemia can occur during or after exercise/physical activity. Delayed hypoglycemia can occur up to 36 hours post exercise.¹
- Vigorous activity, day-long activity, or those with a history of delayed hypoglycemia may need to adjust intermediate-acting or long-acting insulin analogue doses or pump basal rates by 30 to 50%. The reduction may be needed the night before, the day of, and/or the night following the activity.² See *Insulin Adjustment for Pump Therapy (CSII) page 153*.
- An insulin pump may be disconnected during exercise for 1 to 2 hours. BG should be checked before disconnecting the pump and upon reconnecting.^{2,3} See *Insulin Adjustment for Pump Therapy (CSII) page 153*.

Insulin Adjustment Guidelines for Planned Activity/Exercise

- Insulin adjustment for activity must be accompanied by BG measurements before, during and after the activity to evaluate effectiveness (records of previous experiences can be used as a guide).¹
- These are guidelines only, specific modifications to insulin depends on the type, intensity, and duration of activity, as well as the individual's prior response to that particular activity.
- Additional quick/fast CHO must be available to treat hypoglycemia even if modifications in insulin have been made.
- If adjusting insulin for activity, adjust the insulin that is peaking at the time of the activity.
- Delay activity if BG is less than target or if over 14 mmol/L with ketones present.
- When someone has already administered their insulin but still plans to exercise, they will need to eat extra CHO to help prevent hypoglycemia. The amount and timing will depend on the duration of the activity as well as the intensity of the activity. Always check BG prior to starting the activity.

Table 3-4: Insulin Adjustment Guidelines for Planned Activity (Those on small doses of rapid-acting insulin may require greater reductions.)

Type of Activity	Duration	Insulin Reduction (Peaking Insulin)
Low Intensity (walking; bowling)	<ul style="list-style-type: none"> • If less than 30 minutes • If greater than 30 minutes 	<ul style="list-style-type: none"> • No adjustment may be necessary • 10% reduction
Moderate Intensity (tennis; swimming; biking)		<ul style="list-style-type: none"> • 20% reduction
High Intensity (running; soccer; hockey)		<ul style="list-style-type: none"> • 30-50% reduction
Prolonged Intensity	<ul style="list-style-type: none"> • Lasting throughout the day 	<ul style="list-style-type: none"> • 50% or greater reduction

Adapted from: IWK Children and Adolescents Diabetes Program. *Activity and Diabetes*. IWK Health Centre, Halifax, NS; 2013.

Table 3-5 Extra CHO Required for Unplanned Activity

Type of Activity	Duration	Extra CHO
Low Intensity	<ul style="list-style-type: none"> • If less than 30 minutes • If greater than 30 minutes 	<ul style="list-style-type: none"> • No extra CHO required • 10 to 15 grams/hour of exercise
Moderate Intensity		1 gram CHO/kg of body weight/hour of exercise (ideally given every 20 minutes during the hour).
High Intensity		1.5 grams CHO/kg of body weight/hour of exercise (ideally given every 20 minutes during the exercise).

Adapted from: IWK Children and Adolescents Diabetes Program. *Activity and Diabetes*. IWK Health Centre, Halifax, NS; 2013.

Reference

1. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. *Can J Diabetes*. 2018;42(Suppl1):S1-S325.
2. International Society for Pediatric and Adolescent Diabetes (ISPAD). ISPAD Clinical Practice Consensus Guidelines 2014. *Pediatric Diabetes*. 2014;15(Suppl. 20):10-290.
3. Walsh J, Roberts R. *Pumping Insulin: Everything You Need for Success on an Insulin Pump + a new chapter on CGMs, 5th edition*. San Diego, CA: Torrey Pines Press; 2013.

Recommended Reading

- Brink S, Joel D, Laffel L, et al. Sick day management in children and adolescents with diabetes. *Pediatric Diabetes*. 2014;15(suppl 20):193-202.
- Colberg S. *Diabetic Athlete's Handbook: Your Guide to Peak Performance*. Champaign, IL: Human Kinetics; 2009.
- Danne T, Bangstad H-J, Deeb L, et al. Insulin treatment in children and adolescents with diabetes. *Pediatric Diabetes*. 2014;15(suppl 20):115-134.
- Robertson K, Riddell MC, Guinhouya BC, Adolfsson P, Hanas R. Exercise in children and adolescents with diabetes. *Pediatric Diabetes*. 2014;15(suppl 20):203-223.

Case Studies – Children/Adolescents

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

Case Study 1: Children/Adolescents

Narrative

Matthew is a 10-year-old boy diagnosed with type 1 diabetes one week ago. At diagnosis, they presented with a casual BG of 29.6 mmol/L and large ketones, but no DKA. Teaching was completed over three days. This week they have resumed normal activities – school, and soccer on Tuesdays from 1900 to 2000 hours. Their mother calls to discuss Matthew’s insulin dose and to review what to do when planning for soccer. They are also wondering how much longer the 0300 hours test is needed.

Physical and Laboratory Findings

- Present weight is 36 kg
- A1C at diagnosis is 11.4%

Current Diabetes Medication

- Intermediate-acting (basal) insulin 16 units ac breakfast
- Rapid-acting (bolus) insulin 7 units ac breakfast
- Rapid-acting (bolus) insulin 5 units ac supper
- Intermediate-acting (basal) insulin 8 units at hs bed

Recent SMBG Results

DATE	BLOOD GLUCOSE						INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	2300	0300	B	L	S	hs bed	
Friday	7.4	3.4	8.9	17.6	18.9	10.4	IA 16 units RA 7 units		RA 5 units	IA 8 units	
Saturday	8.4	4.0	9.2	16.8	15.9	9.6					
Sunday	6.8	3.6	8.7	15.2	13.6	9.4					

Case Study 1 Children/Adolescents Questions

1. What information do you need to know before making dose changes?
2. What insulin changes would you suggest?
3. How would you advise the mother to manage soccer?

Case Study 1 Answer Sheet

1. Review the following:

- Food intake/activity level in the morning. Explore possible causes of hypoglycemia.
- Treatment for hypoglycemia.
- Food choices at supper/evening snack.
- Explore possible causes of hyperglycemia at hs bed/2300.

2. If no food/activity causes found, suggest the following:

- Decrease the morning rapid-acting insulin by 1 to 2 units because of hypoglycemia before lunch.
- Increase supper rapid-acting insulin by 1 to 2 units to correct hyperglycemia at hs bed.

3. Instructions for managing soccer or any planned exercise/physical activity would include:

- Review that response to exercise/physical activity is very individual and extra SMBG is needed to help decide on action needed.
- Soccer is a moderate to high intensity sport; therefore, Matthew would require 1.5 grams/kg of CHO to cover each hour of exercise. Matthew's mother would give them $1.0-1.5 \times 36 \text{ kg} = 36$ to 54 grams of CHO before their soccer game.
- Test BG before, during, and post game. A 0300 hours test would also be recommended that night to determine if they have delayed hypoglycemia. This can help with planning for future activities/sports.
- If delayed hypoglycemia does occur, a decrease in the bedtime intermediate-acting insulin could be recommended for future activity along with extra BG checks.
- Insulin adjustment can be used as an alternative to an activity snack.
- If low BG levels develop despite activity snack, a decrease in insulin before the activity may also be required.
- If the BG level rises during the game but falls after the game, give the snack after the game. Or some before and some after.
- If the 0300 hours BG has been stable for three nights, and there is no change in their bedtime intermediate-acting insulin, and no extra evening physical activity, the 0300 hours BG can be omitted.

Case Study 2: Children/Adolescents

Narrative

Kirsten is a 2-year-old with type 1 diabetes. They were diagnosed at age 18 months. Their mother calls worried about low BG levels and decreased appetite. When asked when the hypoglycemia was happening, the mother reported hypoglycemia almost every morning around 1000 hours. Kirsten has insulin and then breakfast at 0800 hours. Lately, however, their mother has had difficulty getting Kirsten to eat all of their breakfast.

Physical and Laboratory Findings

- Present weight is 12 kg

Current Diabetes Medication

- Intermediate-acting (basal) insulin 1 unit ac breakfast
- Rapid-acting (bolus) insulin 0.5 units ac breakfast
- Rapid-acting (bolus) insulin 0.5 units ac supper

Recent SMBG Results

DATE	BLOOD GLUCOSE						INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	2300	0300	B	L	S	hs bed	
Nov 5	8.4	15.8	10.9	9.8	13.6		IA 1.0 units RA 0.5 units		RA 0.5 units		Low between bkfst and lunch.
Nov 6	8.7	13.6	9.2	8.8	14.2						Low between bkfst and lunch.
Nov 7	12.6	9.2	8.4	8.9	17.6						
Nov 8	7.6	8.7	8.9	9.2	15.6						Low between bkfst and lunch.

Case Study 2 Children/Adolescents Questions

1. What are the BG goals for this age group?
2. What can the mother do to decrease the chance of hypoglycemia mid-morning?
3. What changes would you make in the insulin/meal plan?
4. What if no rapid-acting insulin is given with 0700 am breakfast, they eat the morning snack at 1000, and is 20.0 mmol/L before lunch at 1200 noon?

Case Study 2 Answer Sheet

- 1. BG goals need to be individualized. This is important in the face of hypoglycemia unawareness which is the case for most toddlers. In addition, extra care is required when toddlers are in a less monitored environment like a day-care. Therefore, a more relaxed target of 6-10 is appropriate.**
- 2. Suggest the following:**
 - Give insulin after breakfast.
 - If BG is less than 10 mmol/L, they may not need any rapid-acting insulin. This should decrease the chance of a mid-morning low.
 - If BG is greater than > 10 mmol/L, they probably need 0.5 units rapid-acting insulin and could give it before or after the meal.
- 3. Suggest the following changes:**
 - Give insulin after breakfast. If the BG is greater than > 10 mmol/L and they eat at least half their breakfast, give the usual amount of rapid-acting insulin (0.5 units). If the BG is less than 10 mmol/L and they eat only half or less of their breakfast, then try without rapid-acting insulin.
 - May need to use an insulin-to-CHO ratio. Or may need to review the CHO amount at breakfast and reduce if appropriate.
 - Look at the readings. Although only a few, the BG readings appear to increase at lunch.
 - The high ac lunch may be related to treating the mid-morning low. Once the mid-morning lows are corrected, the ac lunch readings may improve and not require further insulin adjustment.
 - As the hs BG readings are in range, it is probably necessary, for the time being (in this age group), to ignore the relatively high 2300 hours BG readings.
 - Consider discussion of insulin pump therapy (CSII) to allow delivery of smaller doses of insulin.
- 4. Suggest the following:**
 - Consider adding some rapid-acting insulin at lunch to correct high BG if necessary.
 - If giving rapid-acting insulin ac lunch, the BG should be 20 mmol/L and no extra activity should be planned. Suggest rapid-acting insulin 0.5 units and retest in two hours.

Case Study 3: Children/Adolescents

Narrative

Marcus is a 14-year-old boy with type 1 diabetes. They were diagnosed at age 10. Diabetes management has been very good. Lately, their parents have noticed very high BG levels at suppertime. They have been increasing the morning intermediate-acting insulin with no change in the supper BG levels. They wonder what else they can do.

Physical and Laboratory Findings

- Present weight is 45 kg
- Recent A1C is 8.2%

Current Diabetes Medication

- Intermediate-acting (basal) insulin 24 units ac breakfast
- Rapid-acting (bolus) insulin 10 units ac breakfast
- Rapid-acting (bolus) insulin 6 units ac supper
- Intermediate-acting (basal) insulin 11 units at hs bed
- An algorithm from last visit

Recent SMBG Results

DATE	BLOOD GLUCOSE						INSULIN				COMMENTS
	ac bkfst	ac lunch	ac supper	hs bed	2300	0300	B	L	S	hs bed	
Sept. 4	7.8	8.4	13.4	8.4	10.2		IA 24 units RA 10 units		RA 6 units	IA 11 units	
Sept. 5	8.2	10.6	15.8	8.7	9.4		IA 24 units RA 10 units		RA 6 units	IA 11 units	
Sept. 6	6.9	7.4	16.2	11.0	12.0		IA 24 units RA 10 units		RA 6 units	IA 11 units	
Sept. 7	6.2	7.8	14.6	6.4	9.2		IA 24 units RA 10 units		RA 6 units	IA 11 units	

Case Study 3 Children/Adolescents Questions

1. What other things do you need to know?
2. How would you determine what insulin adjustments to make?
3. Construct an algorithm for Marcus. What information would you use?

Case Study 3 Answer Sheet

1. Additional information that would be helpful includes:

- Find out if there are any lows in the afternoon with the increase in intermediate-acting insulin in the morning.
- Ask Marcus to check his BG after school; before their afternoon snack.
- Check the size of the afternoon snack. If it is a large snack, is it because of the lows or are they just hungry?
- Check the time between the afternoon snack and supper. If BG levels are OK after school but high at supper, it may be related to the snack.
- Are they using his algorithm?

2. Determine appropriate adjustments.

- Adjustments would depend on information gathered (see above).
- If high BG levels at supper are related to the afternoon snack, they may need to space the afternoon snack so it is two hours before supper. If this is not possible, they may need rapid-acting insulin with their afternoon snack if they are willing.
- If lows are occurring before the afternoon snack, they will require a reduction in the morning intermediate-acting insulin.
- They are 14 years old; so discussion regarding more intensive therapy should be considered (i.e., basal-bolus regime) – adding rapid-acting insulin at lunch and possibly switching to long-acting insulin analogue to provide 24-hour basal coverage.
- Consider teaching use of an insulin-to-CHO ratio as they may benefit from this.

3. To construct an algorithm, you could:

- Determine his ISF by using the ISF formula.
- **TDD = 51 units**
- **ISF = $\frac{100}{51} = 1.9$ (2)**

1 unit of rapid-acting insulin will lower their BG by 2 mmol/L.

OR

- Use their previous experience/response to insulin. Marcus and their parents have found that 1 unit of rapid-acting insulin can lower his BG by 3 to 4 mmol/L.
- In this case, you would use their previous response to insulin as your guide. Their algorithm would then be as follows:

Blood Glucose (mmol/L)	Basal Insulin	Rapid/Short-Acting (Bolus Insulin)				Basal Insulin
		Bkfst	Lunch	Supper	hs bed	
4-7	IA 24 units	RA 10 units		RA 6 units		IA 11 units (hs)
7.1-10.0		0		0		
10.1-14.0		+1		+1		
14.1-18.0		+2		+2		
greater than 18		+3		+3		

Case Study 4: Children/Adolescents

Narrative

Mary is a 13-year-old diagnosed with type 1 diabetes one year ago. They were started on MDI, using a long-acting insulin analogue at bedtime and an insulin-to-CHO ratio with breakfast, lunch, and supper. Most nights Mary eats just a small bedtime snack and does not give insulin with this.

Physical and Laboratory Findings

- Present weight is 44 kg
- Recent A1C is 8.3%

Current Diabetes Medication

- Mealtime ratios: breakfast: 1:10; lunch and supper: 1:15
- Long-acting insulin 16 units at bedtime

Recent SMBG Results

DATE	BLOOD GLUCOSE					COMMENTS
	ac breakfast	ac lunch	ac supper	hs bed	2300 hours	
March 1	7.4	15.4	8.2	3.6	18.4	
March 2	6.8	13.2	6.5	3.4	20.9	
March 3	10.2	16.8	5.8	4.4	17.6	
March 4	7.6	12.5	7.9	3.8	22.8	

Case Study 4 Children/Adolescents Questions

1. Looking at their recent SMBG results, identify where adjustments need to be made first. What would be the impact of this correction?
2. What additional issues need to be addressed and what supporting information do you need?

Case Study 4 Answer Sheet

1. The low glucose readings at bedtime (hs) should be corrected first, probably related to too much insulin at supper or increased activity. Lower the supper insulin. The present ratio is 1:15, so consider changing to 1:20. Ask Mary to test this new ratio.

The high readings at 2300 may be related to overtreatment of lows at bedtime. Once the bedtime BG readings are within target, review these again. If the glucose at 2300 hours continues to be elevated, Mary will need to add rapid-acting insulin with the bedtime snack. Usually at bedtime you would start with a less aggressive ratio, so start with 1:25 or 1:30. Ask Mary to monitor this and adjust as needed.

2. The BG readings at lunch are elevated. Presently, Mary does not take insulin for snacks. You will need to determine if they are eating a morning snack. Ask them to test before the snack or 2 hours after breakfast to determine if the insulin-to-carb ratio is working. If they have a reading in within target at 2 hours pc and high at lunch, they may need rapid-acting insulin for their morning snack. Check to see if they still need their morning snack.

Insulin Adjustment for Pump Therapy (CSII)

Key Points

- Insulin pumps deliver insulin via continuous subcutaneous infusion in increments as small as 0.025 to 0.1 units/hour depending on the pump.
- Insulin pumps are programmed to deliver calculated basal rates as a continuous subcutaneous infusion of insulin (CSII) over a 24-hour period.
- Rapid-acting insulin U100 (100 units/ml) is the recommended insulin for pump therapy.
- Insulin boluses are given to cover carbohydrates (CHO) for meals/snacks. The bolus dose is generally calculated using an insulin-to-CHO ratio (grams or choices). Fixed meal doses for known CHO content can be used as an alternative.
- It is important that the client is able to calculate CHO accurately. Often a refresher is required before pump therapy is implemented.
- It is helpful to keep CHO intake and activity levels reasonably consistent at the start of pump therapy until BG levels are in the target range. This is to allow basal doses to be established. Omission of snacks and avoidance of alcohol during the adjustment period (learning) is also helpful.
- Frequent, accurate BG monitoring (a minimum of four to six tests a day) is an essential component of pump therapy. BG tests before (ac) meals, bedtime, 2400 hours, and 0300 hours are necessary to fine-tune initial basal rates.
- BG tests ac and 2-hr after (pc) meals are necessary to establish/confirm appropriate bolus doses and individual insulin-to-CHO ratios.
- Continuous glucose monitoring (CGM), or sensor-augmented therapy for pump users, may be helpful to identify periods of glucose variability¹ and improve glycemic control.
- Once the initial basal and bolus doses are calculated (formulas for determining these are found in pump therapy manuals), it is important to fine-tune basal and bolus doses; and develop a correction formula or Insulin Sensitivity Factor (ISF) that is client-specific (much like individual algorithms).
- Speed of development of diabetic ketoacidosis (DKA) is quicker with pump use - usually, it is caused by pump infusion site problems or other issues including a displaced catheter, empty reservoir, kinked tubing, or a pump mechanical issue. Frequent testing of BG and appropriate management of hyperglycemia, including ketone testing, will decrease the risk of DKA.
- It is important to change infusion set/reservoirs as well as infusion sites every two (48 hours) to three days (72 hours) to ensure adequate insulin delivery and prevent infection.
- Clients/families/caregivers should be encouraged to:
 - use the bolus calculator for all types of boluses
 - download regularly and review results for patterns
 - keep records of current pump settings (including basal rates and bolus doses)
- When travelling with a pump, see *Pump Considerations for Travel*, page 96 for further information. Most pump companies will offer loaner pumps when travelling outside of Canada.

It is recommended that a prerequisite to doing insulin adjustments with CSII is that the diabetes educator (nurse or dietitian) is a certified pump trainer as well as being certified in insulin dose adjustment. This section does not include information learned through certification for pump training.

Indications and Advantages of Pump Therapy

Indications^{2,3}

- Clients with insulin-treated diabetes who have met established criteria for insulin pump therapy must be motivated and interested in optimizing glycemic control. People with the following issues may find increased benefit from insulin pump therapy:
 - Frequent hypoglycemia, nocturnal hypoglycemia, hypoglycemia unawareness, and exercise-induced hypoglycemia
 - Dawn phenomenon (early morning rise in glucose caused by release of counter-regulatory hormones and cortisol)
 - Pregnancy or planning conception
 - Varied lifestyle/schedules
 - Wide fluctuations in BG levels
 - Gastroparesis
 - Recurrent diabetes-related hospitalizations
 - Lower insulin needs (marked insulin sensitivity)
 - Infants and toddlers
 - Client/family choice

Advantages^{2,3,4}

- Currently the most precise way to mimic normal insulin secretion, with the potential to achieve improved glycemic control and also reduce glucose variability.
- Individualized basal rates can help reduce nocturnal hypoglycemia and counteract the dawn phenomenon.
- The severity and frequency of hypoglycemia may be decreased.
- Temporary basal rates better match short-term physiological needs, e.g., during short-term illness. These can also be used to reduce the possibility of exercise-induced hypoglycemia.
- An insulin delivery system to assist with travel, work schedules, and challenging lifestyle events that also offers increased flexibility and perhaps an improved quality of life.
- Far fewer needles a day (i.e., reduced to one every 3 days for the site change).

Calculating Basal and Bolus Requirements for Pump Therapy

- Start below the requirement and titrate up safely.
- Pre-pump total daily dose (TDD) is usually reduced when starting pump therapy. Generally, there is an average reduction of 25% from pre-pump TDD.² It may range from a 5 to 40% reduction.³
- Client age and puberty stage may need to be considered.
- An alternative method for determining the starting insulin pump TDD is based on body weight. The TDD is determined by using the client weight in kilograms (kg). For adults it would be times 0.53 units/ kg of body weight and for children prior to puberty, 0.44 units per kilogram.³
- A combination of the two methods using the weight method formula and the current TDD via injections reduced by 25% could be considered. An average of these two values is then taken.²

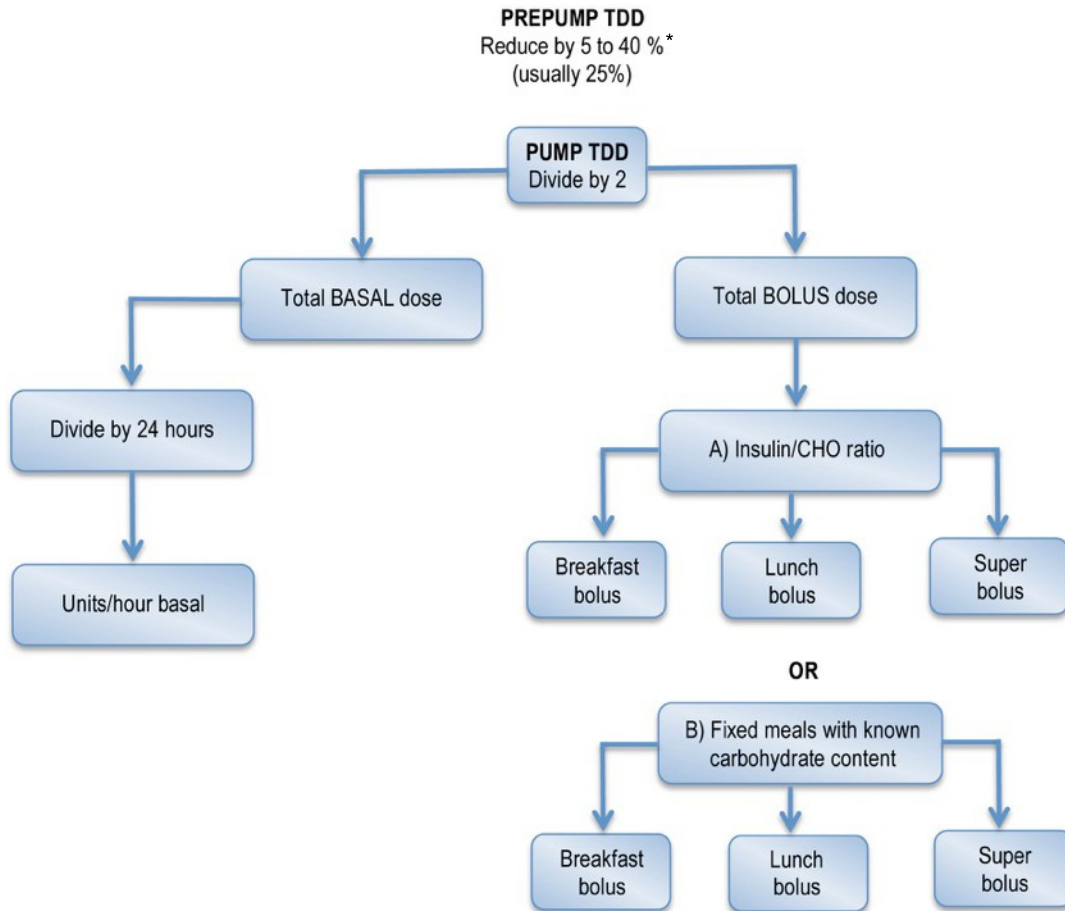
Preparation for the Pump Start Day

- The last dose of intermediate-acting insulin is taken the evening before the pump start and then discontinued. It may be suggested to take this last dose at least 12 hours before the actual start time of pump therapy. Lowering of the bedtime dose may not be required unless recent nocturnal hypoglycemia has been problematic.
- If long-acting analogues are used, reduce the supper or bedtime dose (previous to the pump start day) by approximately 50% the evening before the pump start.⁵ *Note below for 42-hour long-acting analogue.
- If the long-acting analogue is only taken once a day in the morning, then the last full dose will be discontinued 24 hours before the pump start.
- Corrective doses with rapid-acting insulin may be necessary to counteract the elevated BG prior to the pump start.
- Dietitian review should be considered to ensure accurate carbohydrate counting skills prior to the pump start day.

***When using 42-hour Long-acting insulin analogue:**

- When the client is using a 42-hour insulin consider giving the last dose 36 hours prior to the pump start and when calculating pump start settings subtract 25%-30% of the TDD.
- Start pump basal at 50% for 12-24 hours as a temporary basal, the ICR may need to be increased temporarily if going low after meals for 12-24 hours.
- Basal rates and bolus ratios may need a more rapid increase as the 42-hour insulin wears off. Remember that it has been decreased by 25-30% on the pump start day.

Examples of Pump Therapy Dose Calculation



* For example, if the A1C is elevated and no hypoglycemia, reduce by less insulin (i.e., 5%). If the A1C is lower with frequent hypoglycemic events, then reduce by more than 25%. This could be as high as 40% to prevent the risk of hypoglycemia.

Insulin Dose Adjustment for Pumps (Basal/Bolus)

Basal Dose Adjustment

- If daytime BG is within target on initiation of pump therapy, start with only one basal rate for daytime and a lower rate the first night.
- Adjust basal rate based on the 2400, 0300, and ac meal SMBG results.
- For elevated BG, adjust the basal rate prior to the time you are aiming to correct (i.e., two to six hours before).
- The goal is for the fasting BG to remain within 1.7 mmol/L of the target BG range. It is best to start in target.
- Temporary basal rate may be used or needed, as directed by the health care team (HCT), to help determine the true insulin requirements.
- Adjust the basal rate by 10 to 20% for BG out of target range.
 - Raise basal rate by 10 to 20% (0.05 to 0.2 units/hour) if BG is higher than target for two to three days in a row, depending on total fine-tuning of daily dose.
 - Lower basal rate by 10 to 20% (0.05 to 0.2 units/hour) if BG is lower than target for two days (change after one low when initiating pump therapy).
 - For very young children, the basal rate may have to be adjusted more finely; e.g., 0.025 units/hour.
- When adding a second basal rate, increase or decrease by 0.05 to 0.20 units/hour increments from the starting basal rate.¹
- In pregnancy, basal rate adjustments are usually made by 0.1 to 0.2 units/hour.
- When an adjustment in the basal rate is made, close monitoring is important to ensure that the glucose levels have corrected to target range. Consider total change of units in that period of time. i.e., 0.2 units/hr x 5 hours = 1 unit.
- By skipping a meal and recording BG every two hours, basal rates can be assessed. For example, test ac breakfast and skip breakfast bolus dose, breakfast and morning snack. Test BG in two hours and ac lunch. If the basal is correct, the BG should not deviate more than 1.7 mmol/L when meals are skipped. Note: This should be done on a day when fasting BG level is within target.
- Due to tighter glycemic control in pregnancy and the increased risk of hypoglycemia, it is recommended that meals and/or snacks not be skipped.
- Unique patterns of basal infusions may be needed by some clients, but most clients' circadian insulin requirements are met with two or three basal rates a day.⁴ Children may need more than two or three basal rates a day.
- Meal Bolus Dose Adjustments
- Adjust bolus dose(s) based on the pc BG result.
- The goal is for the BG not to increase more than 2.8 mmol/L from the preprandial level 2-hours pc meal,² and to end up no more than 1.7 mmol/L above preprandial levels 4 to 5 hours pc meal.³
 - Adjust pre-meal bolus dose by 10% or adjust the insulin-to-CHO ratio by 2 grams at a time or consider the typical CHO eaten and calculate the difference in dose. People on a low dose may require higher changes (e.g., 3 to 5 grams to make a dose difference of 10%).

For specific populations, increases or decreases in basal adjustments may differ.

Insulin-to-CHO ratio can vary between individuals and differ from meal to meal in the same client

- o It is important to start the meal in BG target range when determining what the insulin-to-CHO ratio should be. See Calculating the Insulin-to-CHO Ratio section, page 63.
- o Continue to SMBG two hours and four hours pc meals for the next two to three days to confirm appropriate adjustment.
- o If unsure whether it is the basal or bolus dose that requires adjusting, consider which SMBG results are out of range. For example, if the 2-hour pc BG is out of target, the dose that needs adjusting is, most likely, the meal bolus (provided meal CHO content and insulin-to-CHO ratio calculations are appropriate). If BG results are out of target range ac meals or more than 2 hours pc, it is most likely the basal dose that needs adjusting.
- o All pumps have the ability to estimate active insulin (insulin on board [IOB]) and are capable of having an effect on the BG). Pumps have a bolus calculator where the insulin-to-CHO ratio can be set; and if the number of grams of CHO are entered, the pump calculates the bolus. The bolus calculator does not account for physical activity.
- o Certain features on insulin pumps may provide the ability to extend meal bolus delivery over time. This is useful for clients with gastroparesis as well as challenges with meals with higher fat content and/or protein content causing a delay in glucose absorption.

Calculating Correction Dose³

(See Calculating the Insulin Sensitivity Factor (ISF) or Correction Dose, page 61)

- Pumps will calculate the correction dose using the programmed ISF once the target glucose is set. This is helpful as it will subtract insulin still calculated to be active (IOB) from a previous bolus and help to avoid hypoglycemia from stacking boluses.

Example:

Jane is 11 years old and on pump therapy. They are just entering puberty. Their present insulin dose is:

Basal rate: 0.7 units/hour
Pre-meal boluses: 6.0 units ac breakfast 4.0 units ac lunch 6.0 units ac supper

Jane's TDD is: $17 + 6 + 4 + 6 = 33$ units

Jane's ISF is: $\frac{100}{33} = 3.0$ mmol/L

Jane's SMBG before breakfast this morning is 12.6 mmol/L. Her target BG ac meals is: 4.0 to 10.0 mmol/L. Therefore, her correction dose for this morning would be:

$\frac{BG - Target}{ISF} = Correction Dose$


$\frac{12.6 - 10.0}{3} = 0.87$ units (0.9 units)

Jane would take her usual 6 units breakfast bolus plus a correction bolus (0.9 units); i.e., 6.9 units before breakfast as recommended by the pump.

Hyperglycemia (Correction Bolus) Dose Adjustment

- Correcting elevated BG is an important element of pump therapy. As the insulin pump only uses rapid-acting insulin, there is a greater risk of developing DKA if insulin delivery is interrupted. This will present as hyperglycemia and ketones.
- If BG is greater than 14 mmol/L, ketones must be checked as outlined below.

Table 3-6: Hyperglycemia Dose Adjustment

Blood glucose over 14 mmol/L with low or no ketones (urine ketones small or blood ketones lower than 0.6)	Blood glucose over 14 mmol/L with ketones (urine ketones moderate or large or blood ketones higher than 0.6)
<ul style="list-style-type: none"> • Determine insulin correction using ISF or Correction Factor. • Use the Ez bolus (Animas), Bolus Wizard (Medtronic), Bolus Calculator (Omnipod), or Bolus Advice (Accucheck) to determine the correction dose. • Give insulin using a pump. • Re-test blood glucose and ketones after 2 hours. If blood glucose has not decreased by at least 3.0 points on the meter or ketones are present or have increased, follow the steps for blood glucose over 14mmol/L with moderate or large urine ketones. <p><i>Note: When blood glucose is over 14 mmol/L with ketones (urine ketones moderate or large or blood ketones higher than 0.6) see right hand side of this table.</i></p> 	<ul style="list-style-type: none"> • Extra insulin must be given using INSULIN SYRINGE OR PEN. • Determine insulin dose using ISF or Correction Factor. • Use the Ez bolus (Animas), Bolus Wizard (Medtronic), Bolus Calculator (Omnipod), or Bolus Advice (Accucheck) to determine the correction dose. • Give 1.5 times the usual correction dose using an insulin syringe or pen. <p>Example: Blood glucose target of 7 mmol/L. Correction factor is 2.0, blood glucose is 21.0 mmol/L, and blood ketones are 2.0</p> $21 - 7 = 14$ $14 \div 2 = 7 \text{ units}$ $7 \times 1.5 = 10.5 \text{ units (if a } \frac{1}{2} \text{ unit pen/syringe is not available, give either 10 or 11 units)}$ <ul style="list-style-type: none"> • Once the insulin has been given by pen or syringe, change the pump site. • Continue testing for ketones and giving insulin as above every 2 hours until ketones are negative. • Call the Diabetes Centre if ketones do not improve. If unable to contact the Diabetes Centre, seek medical attention and go to the local Emergency Room.

Source: Diabetes Care Program of Nova Scotia. *Insulin Pump Initiation for Young Adults/Adults in Nova Scotia Diabetes Centres: Standardized Process with Patient and Provider Tools*. Halifax, NS: Author; 2013.⁶

See Section 2 – Supplemental Dose Adjustment, Calculating the Insulin Sensitivity Factor (ISF) or Correction Dose, page 61.

Sick Day Management on an Insulin Pump*

- Test BG every two to four hours during the day when feeling ill and at least once in the middle of the night.² Always check the BG before going to bed, especially when feeling unwell.
- Check for ketones if BG is over 14.0 mmol/L.
- Take a correction bolus dose of rapid-acting insulin by syringe/pen if the BG greater than 14 mmol/L on two consecutive occasions; or if ketones are present when ill (see Table 3-6 page 159). If BG is not improving, check the expiry date on the insulin vial.
- If ketones are present, give 1.5 times the usual insulin dose (as the correction bolus) using insulin syringe or pen (see Table 3-6, page 159). Remember that the active insulin or insulin on board should not be subtracted from the correction bolus.
- Continue to use insulin by syringe/pen until blood ketones are below 0.6 in the blood or trace in urine.
- Always change the infusion site/set and insulin reservoir before resuming the insulin pump.
- If a new site does not alleviate hyperglycemia, then troubleshoot other possibilities i.e., tubing not primed, insulin has expired, poor site choice, menstruation, and illness.
- Consider raising the basal (temporary basal) if the BG continues to remain elevated (after ruling out site/pump technical issues). This will be in conjunction with corrective bolus doses. Basal rates may need to be increased for the duration of the illness.
- If not eating at all but not vomiting, drink 6 to 8 oz of fluid every hour (amounts may be smaller for young children). It is suggested to switch back and forth between fluids that contain sugar, such as soft drinks and juice and sports drinks for one hour, and fluids that do not contain sugar, such as diet pop, tea, and/or water for the other hour. It is important to also choose some liquids that contain salt such as soups or bouillon or electrolyte solutions such as sports drinks or Pedialyte.
- Check BG frequently during time of illness and correct as needed.

DKA Management on an Insulin Pump*

- DKA should not be managed by a pump. The pump should be stopped and DKA managed per a DKA protocol with IV insulin
- Always change the infusion set/insulin reservoir and infusion site before resuming the insulin pump.
- Consider troubleshooting possibilities as to why DKA happened, (i.e., pump/site failure, forgetting to bolus, expired insulin, unprimed tubing, empty reservoir, change in routine, etc.) and teach accordingly.

*For additional information, see Section 2 – Insulin Adjustment for Illness and Prevention/Treatment of DKA, page 76.

Exercise with Pump Therapy*

Activity Considerations

- Pumps may be continued, suspended or disconnected for exercise. Some clients prefer, and certain activities require, the pump to be disconnected (removed) for practical reasons (to protect the pump from damage or water).³
- Different types of exercise can affect BG differently. Extra glucose checks and keeping good records can help individualize the approach to exercise.
- Introduction of moderate or strenuous activity should be restricted until initial basal rates are established.
- Exercise that is prolonged or intense causes depletion of muscle glycogen stores and an increase in muscle sensitivity to insulin. This can cause BG to drop several hours after exercise has been completed as the body replenishes the glycogen stores. This is known as delayed onset hypoglycemia.⁷
- Insulin sensitivity can remain elevated for up to 24 hours post-activity. Peak insulin sensitivity can occur up to 7 to 11 hours post exercise.^{8,9}
- When activity lasts for longer than 30 minutes, there typically needs to be adjustments to insulin given for carbohydrates and correction doses for basal rates or both.⁹
- A general rule of thumb for most moderate-intensity exercise (e.g., tennis, swimming, cycling) is to have 15 to 30 grams of carbohydrates for every 30 to 60 minutes of exercise. High intensity activity, such as hockey, soccer and strenuous cycling, will require 30 to 60 grams of carbohydrates every hour.⁶
- The symptoms of hypoglycemia and hyperglycemia can be masked by exercise, it is important to check BG levels often when starting a new exercise.⁹
- Monitor BG before the activity, every 30 minutes during the activity, after the activity, and before bed. Overnight checks may also be required.⁹
- Exercising with ketones can lead to higher glucose and ketone levels. More ketones may precipitate ketosis/DKA. It is important to check for ketones when glucose levels are elevated before beginning the activity.⁹
- Refrain from exercising if fasting glucose is greater than or equal to 14 mmol/L and ketones are present.⁸ Also, be cautious if glucose levels are 16.7 mmol/L and no ketones are present.¹⁰ Check BG often and react accordingly.

Basal Rate Considerations for Exercise

Using Temporary Basal Rates

- A reduced temporary basal rate can be started 60 to 90 minutes before an activity. This decreases the level of circulating insulin during exercise .⁸
- Reduced temporary basal rates should be encouraged before, during, and/or after exercise. Basal rates may need to be decreased by 20 to 80% depending on the duration and intensity of the activity.⁹
- For all-day activities, a temporary basal rate may need to run at 10 to 20% reduction or more overnight the day before the activity and the evening of the event to help prevent hypoglycemia. This requires more BG monitoring.^{8,9}

Pump Suspend/Disconnect

- The pump can be disconnected 60 to 90 minutes before an activity. This decreases the level of circulating insulin during exercise.⁸
- If the pump is disconnected or suspended for more than 90 minutes, this may cause hyperglycemia and ketosis may develop quickly.³ Monitor BG regularly to assess for this.
- To prevent hyperglycemia, clients can re-connect regularly (e.g. 60 minutes but at least every 120 minutes) and give a portion of the missed basal rate as a bolus (typically 50%).⁷
- When the client is not exercising at a level that requires complete elimination of the basal rate, a portion of the missed basal dose (30 to 50%) may be given as a bolus when the client disconnects the pump. Or part way through the activity, if there is a consistent pattern of hyperglycemia after exercise based on the clients prior experience.
- BG monitoring is necessary before disconnecting and upon reconnection of the pump.³

Bolus Considerations for Exercise

- To avoid hypoglycemia, bolus reductions should be made depending on the time between the before-activity meal and the duration and intensity of the activity:
 - If the meal is more than an hour and up to 2 hours prior to the activity, reduce the bolus by 25 to 75% (reduction depends on the intensity and duration of the activity).⁹
 - It is often helpful to reduce a pre-activity bolus by 50% for carbohydrate intake 30 to 60 minutes prior to exercising.⁷
- Intense, short-duration anaerobic exercise may raise BG with the potential for hypoglycemia later. Correction boluses may be suggested to manage post-exercise hyperglycemia but often should be reduced to avoid later hypoglycemia. Glucose testing and record keeping will aid in this decision.³
- Extra carbohydrates post activity is often the best choice to prevent post-exercise hypoglycemia for short duration or high intensity anaerobic activities.⁸

Sensor augmented pump technologies are not discussed here. Refer to pump trainer guidelines for information on these technologies.

*For additional information, see Section 2 – Insulin Adjustment for Exercise/Physical Activity, page 87.

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Recommended Reading

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Case Studies – Insulin Dose Adjustment for Pump therapy

- In preparation for writing the DMF certification exam and using these guidelines in daily practice, the following case studies should be reviewed and discussed with your Medical Advisor or their designate.
- For each case study, read through the narrative and case study questions.
- To answer the questions, draw on your own knowledge and experience, see related section(s) in the manual, and see references and recommended readings.
- Read through the case study answer sheet, compare/contrast your answers, and review/discuss with your Medical Advisor or designate.

Case Study 1: Insulin Dose Adjustment for Pump Therapy - Illness

Narrative

Mary is a 56-year-old retired teacher who has had type 1 diabetes for 30 years. Mary and their husband love to travel, and they recently drove to New York to visit Mary's sister who also has type 1 diabetes. Both Mary and their sister use the insulin pump as their preferred delivery system and have both indicated that they have been able to improve their A1C since pump therapy was introduced.

Upon arrival in New York, Mary noticed that their blood glucose (BG) was a bit higher than usual. The following evening, Mary felt unwell – abnormally thirsty with slight nausea and abdominal discomfort. They felt like they had a stomach flu. They had already given themselves a bolus of 15.2 units for supper with a correction 2 hours earlier. Their sister urged them to test for blood ketones as well as their BG. Mary was surprised to discover that their BG was 25 mmol/L with 1.8 mmol/L blood ketones present. (*See Sick Day Guidelines, Hyperglycemia Dose Adjustment Table 3-5, page 142*).

Physical and Laboratory Findings

- Present weight is 68.1kg
- BMI is 28
- A1C is 7.6%

Current Diabetes Medication

- Basal:
 - 2400 hours 0.80 units/hour
 - 0430 hours 0.95 units/hour
 - 1000 hours 0.85 units/hour
- Bolus (Insulin-to-CHO ratio):
 - Breakfast = 1:8 (usual dose 3 units)
 - Lunch = 1:7 (usual dose 9 units)
 - Supper = 1:7 (usual dose 10 units)
- ISF: 2.3 units (24 hours)
- Targets: 5-7 mmol/L
- Active insulin: 4 hours
- IOB: 7.6 units

Recent SMBG Results

DATE	BLOOD GLUCOSE								COMMENTS
	ac bkfst	pc bkfst	ac noon	pc noon	ac supper	pc supper	hs bed	0300 hours	
June 20	7.0	7.8	6.2	7.2	7.3	7.9	6.9	-	
June 21	6.0	7.8	5.2	7.0	5.0	6.9	7.0	-	
June 22	8.2	9.2	10.0	11.0	12.0	13.8	11.9	-	Site change
June 23	12.5	13.7	13.9	17.2	19.0	25.0 + 1.8 ketone	16.0 +1.4 ketone	15.0 + 0.6 ketone	Fewer ketones BG lower

Case Study 1 Illness Questions

1. What immediate sick day management action should be carried out to reverse ketone levels and correct hyperglycemia?
2. What are some practical points that Mary can use when troubleshooting hyperglycemia in insulin pump therapy? Please list any 10 points.

Case Study Answer Sheet

1. **Since the BG greater than 14 mmol/L and the blood ketone level is already 1.8, the insulin dose requirement should be taken by syringe or pen.** Mary needs to inject extra insulin. Mary will be required to take 1.5 times the usual insulin dose (as a bolus correction dose) of rapid-acting insulin according to the insulin adjustment guidelines for diabetic ketoacidosis (DKA) prevention when on an insulin pump. They must check their BG and blood ketones every one to two hours and should continue to use the insulin syringe/pen until ketones have cleared. Once they have confirmed that the pump is working and the infusion set/reservoir, infusion site, and insulin vial have been changed prior to resuming usage of the pump. If the BG remains high, the basal rate should be raised on a temporary basis. The basal rate should be increased to keep the pre-meal and overnight BG level within 1.7 mmol/L of the baseline level. If the pump has malfunctioned, they should call the 1-800 number on the back of their pump for a replacement. Mary will need to be prepared to revert to their former long- acting insulin for their basal insulin and their rapid-acting insulin for their meal boluses until the new pump arrives.

Mary still has some active insulin on board (IOB) they will need to add the IOB to their correction bolus as they may not have received this correction properly in the first pump bolus. Remind Mary not to subtract the IOB if they are using their bolus calculator to help figure out their dose.

2. **Mary should follow a trouble shooting approach for their pump and must be aware that even partial interruption of insulin flow can result in hyperglycemia, and complete interruption can result in ketosis or ketoacidosis within a few short hours.**

- Any of these can occur even if the infusion site/set has been recently changed:
 - Red, tender, and swollen catheter site
 - Leakage, breakage, or kinking of tubing
 - Battery failure
 - Empty reservoir or cartridge
 - Improper positioning of reservoir or piston rod
 - Improper basal rate programming
 - Air in tubing
 - Illness
 - DKA
 - Menstrual cycle fluctuations
 - Omitted bolus, missed bolus, or improper amount given
 - Crimped catheter or needle not penetrating skin
 - Change in usual routine (prolonged sitting with travel)
 - Suspect site not absorbing insulin (site inserted in hypertrophied area)
 - Forgetting insulin dose or no basal delivery
- Mary should check pump history for insulin delivery (basal/bolus).

Case Study 2: Pediatric Insulin Dose Adjustment for Pump Therapy & Activity/Exercise

Narrative

Andrew is a 12-year-old boy who has been on pump therapy for one year. They are joining a soccer team this summer and has practices Monday and Thursday from 1800 to 2000 hours, with games every Saturday from 1600 to 1800 hours. Their games are going to be more intense than their practices. Their basal dose is 50% of their total daily dose.

Physical and Laboratory Findings

- Present weight is 45 kg
- Recent A1C is 8.5%

Current Insulin

- Basal:
 - 2400 to 0800 0.6 units/hour
 - 0800 to 1200 0.8 units/hour
 - 1200 to 2000 0.7 units/hour
 - 2000 to 2400 0.9 units/hour
- Bolus (Insulin-to-Carbohydrate [CHO] ratio):
 - Meals = 1:10
 - Snacks = 1:15
- ISF: 4
- Targets: 7.0 mmol/L
- Active Insulin: 4 hours
- IOB: none

Recent SMBG Results

BLOOD GLUCOSE (BG)			
ac Breakfast	ac Lunch	ac Supper	hs (Evening/Bedtime)
9.8	8.2	7.7	10.1
7.4	9.2	6.5	9.5
8.1	8.5	7.9	8.6
6.4	8.0	7.3	9.3

Case Study 2 Pediatric Insulin Dose Adjustment for Pump Therapy & Activity/Exercise Questions

1. What time of day are their activities?
2. What insulin changes would you suggest for these times (before and after supper)?
3. How would you assess effectiveness of activity insulin adjustment?
4. What about delayed hypoglycemia?
5. What instructions would you give that are pump-specific?

Case Study 2 Answers

1. **The exercise times change. Practice is after supper and games are before supper.** All events last for 2 hours.
2. For practice **after** supper:

There are different approaches that could work and tracking the approach and recording the result is the best way to work this out. Insulin adjustment is preferred over adding extra CHO for planned activity.

- A. CHO bolus considerations for practice *after* supper:** This would be the best place to start. As the activity is after the meal, lower the CHO bolus to help reduce insulin levels. They can bolus less insulin for the supper meal on practice days, as this meal is two hours before their game.

They should start with 25%-50% less of the mealtime bolus prior to the soccer practice. (They may need to reduce even more based on his post-activity BG results.)

If the BG is high before disconnection and there has not been a correction bolus in the last two hours, they should consider giving half of the usual BG correction.

OR

- B. Basal considerations (off pump procedure) for practice *after* supper:** If the pump is to be removed for the practice (two hours), then it may be necessary to replace some of the basal that will be missed. It is likely best to try just disconnecting with no replacement the first time. Then, if they are running high during or immediately post practice, 30 to 50% of the missed basal could be given as a bolus prior to removal of the pump.

For example, $0.7 \text{ units/hour} \times 2 \text{ hours} = 1.4 \text{ units}$. Fifty percent (50%) would be 0.7 units, or 30% would be 0.4 units. Therefore, they would take 0.4 units to 0.7 units bolus before removing the pump. They can also do this one hour at a time by reconnecting hourly to do this. BG monitoring is necessary before disconnecting and upon reconnecting.

For games **before** supper: Their games are usually much more intense than their practice times. Insulin adjustment is preferred over adding extra CHO for planned activity.

NOTE: Referees usually require that the pump be removed.

- A. Bolus adjustment (off pump procedure) for games *before* supper:** They should have their afternoon snack but omit the bolus. Disconnect the pump and check BG half-way through the game. Reconnect and bolus 50% of missed basal if BG rising. BG monitoring is necessary before disconnecting and upon reconnecting. If the BG is high before disconnection and there has not been a correction bolus in the last two hours, they should consider giving a half of the usual BG correction.

OR

- B. Basal adjustment for games *before* supper:** Leave the pump on and use a temporary basal of minus 30 to 50%. This may need to start 60-90 minutes before the activity and continue until the

game is over. The basal rate may need to continue at the lowered basal rate after the game as well.

3. **All insulin adjustments for exercise are assessed by doing frequent BG monitoring before, during, and after the exercise.**
4. **To prevent delayed hypoglycemia, there will be a need for extra BG testing, especially overnight.** A temporary basal pattern can be programmed using an insulin reduction of 20 to 30% overnight. The 0300 hour BG test will determine if there is a need to continue with the reduced basal until morning.
5. **For pump therapy, it is important to protect the pump from damage during exercise involving physical contact.** In these situations, the pump should be removed for a period no longer than two hours without testing and reconnecting to bolus as required. Exercise should be delayed if the BG is over 14 mmol/L with ketones present until ketones are negative.

It will be important for Andrew to check with their coach to make sure they can wear their pump while playing soccer.

Section 4: Tables

- Table 4.1 Formulary Coverage of Insulin Therapies & Indications for Use in Various Populations
 - (Updated July 2019)
- Table 4.2: Formulary Coverage of Non-Insulin Therapies (oral and injectable) and Indications for Use in Various Populations
 - (Updated July 2019)
- Table 4.3: Provincial Formulary Coverage of Injectable Combination Therapies & Indications for Use in Various Populations
- Table 4.4: Non-Insulin Therapies and Insulin – Considerations for Use
 - (Updated July 2019)

Provincial formulary links

- **Nova Scotia:** <http://novascotia.ca/dhw/pharmacare/formulary.asp>
- **New Brunswick:** http://www.gnb.ca/0212/pdf/nbpdp_formulary-e.pdf
- **Newfoundland & Labrador:** <http://www.health.gov.nl.ca/health/prescription/newformulary.asp>
- **Prince Edward Island:** http://www.gov.pe.ca/photos/original/hpei_formulary.pdf

TABLE 4.1 Formulary Coverage of Insulin Therapies & Indications for Use in Various Populations

INSULIN THERAPY	Formulary Coverage				Indication for use with:		
	NS	NB	NL	PE	ADULTS [◇]	PEDIATRICS [◇]	PREGNANCY [¥]
BOLUS (Prandial/Meal Time) Insulins							
Rapid-acting Insulin Analogues (clear)							
<ul style="list-style-type: none"> Insulin Aspart 100u/ml (NovoRapid®) Insulin Aspart 100u/ml (Fiasp®) Insulin Glulisine 100 u/ml (Apidra®) Insulin Lispro 100 u/ml (Humalog®) Insulin Lispro 200 u/ml (Humalog®) 	● ○ ● ● ¹ ○	● ○ ● ● ² ○	● ○ ● ● ³ ○	● ○ ● ● ³ ○	✓ ✓ ✓ ✓ ✓	No data < 18yrs [■] ✓ ✓ ✓ ✓	No data available for use in pregnancy [■] No data available for use in pregnancy ✓ ✓
Short-acting Insulins (clear)							
<ul style="list-style-type: none"> Insulin Regular 100 u/ml (Humulin® -R) Insulin Regular 100 u/ml (Novolin® ge Toronto) Insulin Regular 500 u/ml (Entuzity®) 	● ● ○	● ● ○	● ● ○	● ● ○	✓ ✓ ✓	✓ ✓ No data < 18yrs [■]	✓ ✓ No data available for use in pregnancy [■]
BASAL Insulins							
Intermediate-acting (cloudy)							
<ul style="list-style-type: none"> Insulin NPH 100 u/ml (Humulin® - N) Insulin NPH 100 u/ml (Novolin® ge NPH) 	● ●	● ●	● ●	● ●	✓ ✓	✓ ✓	✓ ✓
Long-acting Insulin Analogues (clear)							
<ul style="list-style-type: none"> Insulin Detemir 100 u/ml (Levemir®) Insulin Glargine 100 u/ml (Lantus®) Insulin Glargine 100 u/ml (Basaglar™) Insulin Glargine 300 u/ml (Toujeo™ SoloSTAR®) Insulin Degludec 100 u/ml & 200 u/ml (Tresiba®) 	● ⁴ ● ⁴ ● ○ ○	● ⁴ ● ⁵ ● ○ ●	● ⁶ ○ ● ○ ○	● ⁷ ● ⁷ ● ● ⁸ ●	✓ ✓ ✓ ✓ ✓	✓ ✓ ✓ No data < 18yrs [■] ✓	✓ ✓ ✓ Only if potential benefit justifies potential risk to fetus [■] No human data available for use in pregnancy.
PREMIXED Insulins							
Premixed Regular and NPH							
<ul style="list-style-type: none"> Humulin® 30/70 Novolin® ge 30/70, 40/60, 50/50 	● ●	● ●	● ●	● ●	✓ ✓	✓	Not recommended in pregnancy. These do not allow for precise dosing as required to attain and maintain blood glucose targets.
Premixed Insulin Analogues							
<ul style="list-style-type: none"> Biphasic insulin Aspart (NovoMix® 30) Insulin Lispro/Lispro protamine (Humalog® Mix 25) Insulin Lispro/Lispro protamine (Humalog® Mix 50) 	○ ○ ○	○ ○ ○	○ ○ ○	○ ● ○	✓ ✓ ✓	✓ ✓ ✓	

● Exception Status; ●=Full Benefit; ○=Not a benefit

◇ Check marks indicate common use/clinical practice. Data for safe use in various ages in pediatrics varies by product.

¥ Reference: Briggs GG, Freeman RK, Yaffe SJ. *Drugs in Pregnancy and Lactation. Ninth edition.* 2011 ■ Reference: Product monograph **NOTE: TABLE 4.1 was updated MAY 2019**

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TABLE 4.1: Formulary Coverage of Insulin Therapies & Indications for Use in Various Populations

TABLE 4.1 Table Key

☛¹ = ES¹

Regular benefit for children 18 years and younger, under Community Services, Family Pharmacare and Diabetes Assistance Programs (full benefit for children 18 years and younger).

For the management of type 1 and type 2 diabetes mellitus in patients 19 years of age and older who are:

- undergoing intensive therapy, i.e., administering three or more injections of insulin per day including basal insulin, **AND**
- testing blood glucose levels 4-6 times per day

☛² = ES²

For patients with type 1 or type 2 diabetes who:

- have experienced frequent episodes of postprandial hypoglycemia, **OR**
- have unpredictable mealtimes, **OR**
- have insulin resistance, **OR**
- are using continuous subcutaneous insulin infusion.

Claim Notes:

- Prescriptions written by New Brunswick endocrinologists and internists do not require special authorization.
- Subsequent refills ordered by other practitioners will not require special authorization.

☛³ = ES³

For patients with insulin-dependent diabetes on multiple insulin dosing (greater than or equal to 3 injections of regular insulin per day) and who are experiencing frequent hypoglycemia or poor glycemic control on their current regimen.

For patients with insulin-dependent diabetes who are using an insulin pump.

Note: HUMALOG KWIKPEN 200 unit/ml should not be administered via a subcutaneous infusion pump or mixed with any other insulin (including HUMALOG 100 units/mL).

For patients with insulin-dependent diabetes who, for convenience purposes, wish to use this insulin and are willing to pay the difference in price from traditional regular insulin (i.e., NLPDP, will pay the cost normally reimbursed for regular insulin (Humulin R) and the patient would be responsible for the difference). **(HUMALOG 100 UNIT/ML VIAL, PEN only)**

☛⁴ = ES⁴

For the treatment of patients who have been diagnosed with type 1 or type 2 diabetes requiring insulin and have previously taken insulin NPH and/or pre-mix daily at optimal dosing, and have:

- have experienced unexplained nocturnal hypoglycemia at least once a month despite optimal management, **OR**
- have documented severe or continuing systemic or local allergic reaction to existing insulin(s).

☛⁵ = ES⁵

For the treatment of patients who have been diagnosed with type 1 or type 2 diabetes requiring long-acting insulin.

Claim Note:

- New requests for coverage of Lantus will not be considered. Basaglar brand of insulin glargine is listed as a regular benefit.

6 = ES⁶

For patients who have been diagnosed with Type 1 or Type 2 diabetes **AND**

- who have experienced unexplained nocturnal hypoglycemia at least once a month despite optimal management with insulin glargine **OR**
- have documented severe or continuing systemic or local allergic reactions to both NPH insulin and insulin glargine **OR**
- who have experienced unexplained nocturnal hypoglycemia at least once a month despite optimal management with NPH insulin and who have documented severe or continuing systemic or local allergic reactions to insulin glargine

7 = ES⁷

For the treatment of patients who have been diagnosed with type 1 or type 2 diabetes requiring insulin and have previously taken all open benefit long acting insulin analogues daily at optimal dosing

AND

- have experienced unexplained nocturnal hypoglycaemia at least once a month despite optimal management

OR

- have documented severe or continuing systemic or local allergic reaction to existing insulin(s)

8 = ES⁸

For the treatment of patients who have been diagnosed with type 1 or type 2 diabetes requiring insulin and have previously used all eligible open benefit long acting insulin analogues at optimal dosing **AND** have experienced unexplained hypoglycemia at least once a month despite optimal management

OR

For the treatment of patients who have been diagnosed with type 1 or type 2 diabetes requiring high dose insulin.

NOTE: TABLE 4.1 was updated MAY 2019

NOTE: TABLE 4.2 was updated MAY 2019

Table 4.2 Provincial Formulary Coverage of Non-Insulin Therapies (oral and injectable) and Indications for Use in Various Populations

NON-INSULIN THERAPIES	Formulary Coverage				Indication for use with:				Other Therapeutic Considerations
	NS	NB	NL	PE	ADULTS*	PEDIATRICS*	PREGNANCY	LACTATION	
ORAL ANTIHYPERGLYCEMIC AGENTS									
Alpha-glucosidase inhibitor • Acarbose (Glucobay®)	●	●	●	●	Type 2	Safety, efficacy not established	Safety not established. Limited human data ¥	No data, probably compatible € ¥	
Insulin Secretagogues Sulfonylureas: • Gliclazide (Diamicon®, Diamicon® MR, generics)	●	●	●	●	Type 2	Not for use <18	Safety not established. Limited human data	No data, alternative preferred € ¥	Glyburide may be considered through the first trimester (under care of a specialist) until insulin is initiated - Diabetes Care Program Nova Scotia (DCPNS)
• Glimepiride (Amaryl®, generics)	○	●	●	●		Safety, efficacy not established	Safety not established. Limited human data ¥	No/limited data, alternative preferred € ▲ ¥	
• Glyburide (Diabeta®, Euglucon®)	●	●	●	●		Not for use <18	Human data suggest low risk ¥	Limited data, probably compatible € ¥	
• Chlorpropamide	○	○	●	○		Safety, efficacy not established	Human data suggest risk in 3 rd trimester ¥	No/limited data, alternative preferred € ▲ ¥	
• Tolbutamide	●	●	●	●	Safety, efficacy not established	Human data suggest risk in 3 rd trimester ¥	Human data suggest risk in 3 rd trimester ¥	Limited data, probably compatible € ▲ ¥	
Meglitinides: • Repaglinide (Gluconorm®, generics)	○	■ ¹	■ ²	○	Not for use <18	Not for use <18	Safety not established ¥	No data, possibly hazardous/ potential toxicity € ¥	
Biguanides • Metformin (generics Glucophage®) • Metformin once daily formulation (Glumetza®)	● ○	● ○	● ○	● ○	Type 2	Safety & efficacy not established	Human data suggest low risk ¥ May have non-glycemic benefits including less: • gestational weight gain, • pregnancy-induced hypertension, • neonatal hypoglycemia • NICU admissions > 24 hrs.	Limited data, compatible € ¥	Use in Polycystic Ovarian Syndrome (PCOS). Use in the first trimester until insulin initiated. Approximately 85% will require add-on insulin. Increasing use in GDM and Type 2 DM
DPP-4 Inhibitor									
• Sitagliptin (Januvia®)	■ ³	■ ⁴	■ ³	■ ³	Type 2	Not for use <18	Safety not established ¥	No data, probably compatible € ¥	
• Saxagliptin (Onglyza®)	■ ³	■ ³	■ ³	■ ³			Safety not established ¥	No data, alternative preferred ▲ ¥	
• Linagliptin (Trajenta®)	■ ³	■ ³	■ ³	■ ³			Safety not established ¥	No data, probably compatible € ¥	
• Alogliptin (Nesina®)	○	○	○	○			Safety not established ¥	No data, alternative preferred ▲ ¥	

*= Exception Status; ■ = Full Benefit; # = Not a benefit

TABLE 4.2: Formulary Coverage of Non-Insulin Therapies (oral and injectable) and Indications for Use in Various Populations

NOTE: TABLE 4.2 was updated MAY 2019

ORAL ANTIHYPERGLYCEMIC AGENTS (CONT)	NS	NB	NL	PE	ADULTS ^x	PEDIATRICS ^x	PREGNANCY	LACTATION [€]
Thiazolidinedione <ul style="list-style-type: none"> Pioglitazone (Actos®) Rosiglitazone (Avandia®) 	● ⁵ ○	● ⁶ ○	● ⁶ ○	● ⁷ ○	Type 2	Not for use < 18	Safety not established †	No data, probably compatible ^{€†}
Sodium Glucose co-transporter (SGLT2) Inhibitors <ul style="list-style-type: none"> Canagliflozin (Invokana®) Dapagliflozin (Forxiga®) Empagliflozin (Jardiance®) Ertugliflozin (Steglatro™) 	● ⁸ ● ⁹ ○	● ³ ● ³ ○	● ³ ● ³ ○	● ³ ● ³ ○	Type 2	Not for use < 18	Safety not established † Not for use in pregnancy [‡]	No data, potential toxicity † Not for use in lactation, may affect developing human kidney [‡]
Combined formulations <ul style="list-style-type: none"> Metformin + Rosiglitazone (Avandamet®) Metformin + Sitagliptin (Janumet®) Metformin + Sitagliptin (Janumet® XR) Metformin + Linagliptin (Jentadueto®) Metformin + Saxagliptin (Komboglyze®) Metformin + Alogliptin (Kazano®) 	○ ● ¹⁰ ● ¹⁰ ● ¹¹ ● ¹² ○	○ ● ¹⁰ ● ¹⁰ ○ ○	○ ● ¹⁰ ● ¹⁰ ○ ○	○ ● ¹⁰ ● ¹⁰ ○ ○	Type 2	Not for use < 18	See recommendations for individual agents, page 1	See recommendations for individual agents, page 1
<ul style="list-style-type: none"> Metformin + Canagliflozin (Invokamet®) Metformin + Dapagliflozin (Xigduo®) Metformin + Empagliflozin (Synjardy®) Metformin + Ertugliflozin (Segluromet™) Linagliptin + Empagliflozin (Glyxambi®) Sitagliptin + Ertugliflozin (Steglujan™) 	○ ● ¹³ ● ¹⁴ ○ ○ ○	○ ● ¹³ ○ ○ ○	○ ● ¹³ ○ ○ ○	○ ● ¹³ ○ ○ ○	Type 2	Not for use < 18	See recommendations for individual agents, page 1	See recommendations for individual agents, page 1
INJECTABLE ANTIHYPERGLYCEMIC THERAPY								
GLP-1 Receptor Agonists: <ul style="list-style-type: none"> Exenatide (Byetta®) Exenatide extended release (Bydureon®) Liraglutide (Victoza®) Dulaglutide (Trulicity™) Lixisenatide (Adlyxine™) Semaglutide (Ozempic®) 	○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○	Type 2 Type 2	Not for use <18 Not for use <18	Safety not established † Safety not established † Not for use in pregnancy, toxic in animal studies [‡] Not for use in pregnancy [‡]	No data, probably compatible ^{€†} No data, alternative preferred † [‡] Not for use in lactation, no data, unknown if excreted in breastmilk [‡] Not for use in lactation [‡]
WEIGHT LOSS AGENTS								
<ul style="list-style-type: none"> Orlistat (Xenical®) Liraglutide (Saxenda®) 	○ ○	○ ○	○ ○	○ ○	Weight loss	Not for use < 12 for use < 18	Contraindicated ‡Contraindicated [‡]	No data, alternative preferred ^{€†} † No human data, not for use [‡]

●= Exception Status; ●=Full Benefit; ○=Not a benefit

‡ Product monograph †Reference: Briggs GG, Freeman RK, Towers, CV, Forinash AB. *Drugs in Pregnancy and Lactation. Ninth edition*; With the exception of orlistat, all product monographs recommend no use in pregnancy.

§ Reference: Micromedex Solutions. *IBM Micromedex*. Available at: <http://www.micromedexsolutions.com>. Accessed: 2019 January 28

€ Reference: Hale TW and Rowe HE. *Medications and Mothers Milk*. Seventeenth Edition. New York, NY: Springer Publishing Company, 2017.

▲ Reference: U.S. National Library of Medicine. *Lactmed: A TOXNET DATABASE*. Available at: <https://www.toxnet.nlm.nih.gov/newtoxnet/lactmed.htm>. Accessed: 2019 February 22

TABLE 4.2: Continued

TABLE 4.2: TABLE KEY

ES	Exception Status Criteria, Key Interpretations
1	For patients with type 2 diabetes who are not adequately controlled by diet and exercise and glyburide and/or metformin or who have frequent or severe hypoglycemic episodes despite dosage adjustment of glyburide.
2	For patients who have failed to respond to or have experienced hypoglycemia from sulfonylureas. Note: Coverage may be considered WITHOUT a Special Authorization request as long as the beneficiary's medication history in the NLPDP database has had a paid (non-reversed) claim for Gluconorm (repaglinide), glimepiride, gliclazide, tolbutamide, chlorpropamide or glyburide in the past year. If there is no history of a previous claim for glimepiride, gliclazide, tolbutamide, chlorpropamide or glyburide the normal Special Authorization Process will be required.
3	For the treatment of type 2 diabetes in addition to metformin and a sulfonylurea in patients who have inadequate glycemic control or intolerance to metformin or a sulfonylurea and in whom insulin is not an option. NB: Linagliptin: For patients with type 2 diabetes mellitus with inadequate glycemic control while on optimal doses of metformin and a sulfonylurea, and for whom NPH insulin is not an option, when added as a third agent
4	For the treatment of Type 2 diabetes mellitus in patients for whom NPH insulin is not an option AND : <ul style="list-style-type: none"> • who have inadequate glycemic control while on optimal doses of metformin and a sulfonylurea when added as a third agent; OR • In combination with metformin when a sulfonylurea is not suitable due to contraindications or intolerance; OR • As monotherapy when metformin and sulfonylurea are not suitable due to contraindications or intolerance
5	For treatment of Type 2 diabetes in patients who have: <ul style="list-style-type: none"> • inadequate glycemic control on optimal doses of sulfonylurea and metformin; OR • demonstrated intolerance or contraindication to metformin and are on optimal doses of sulfonylurea; OR • demonstrated intolerance or contraindication to sulfonylurea and are on optimal doses of metformin Patient must have a recent A1C of < 10% unless insulin therapy is inappropriate for the patient. Duration of initial approval will be 6 months; further coverage will require demonstrated evidence of efficacy (a reduction of A1C of 0.7 observed to continue coverage.)
6	For patients with type 2 diabetes who are not adequately controlled by diet, exercise, and drug therapy. Drug therapy should include a trial of a sulfonylurea and metformin, alone and in combination, unless one of these agents is not tolerated or is contraindicated. NL: For the treatment of type 2 diabetes in patients who are inadequately controlled on a combination of sulfonylurea and metformin, at maximum dosages, or in whom these agents are contraindicated or not tolerated
7	For treatment of patients diagnosed with Type 2 diabetes, and who have: a) Inadequate glycemic control ¹ on optimal doses ² of Sulfonylurea and Metformin; OR b) Demonstrated intolerance or contraindication to Metformin ³ and are on optimal doses ² of Sulfonylurea; OR c) Demonstrated intolerance or contraindication to Sulfonylurea ⁴ and are on optimal PEI Pharmacare doses ² Metformin <ol style="list-style-type: none"> 1. Most recent (within the past 12 months) HbA1C required:>7% and <10%. The addition of a thiazolidinedione would not be expected to decrease the HbA1C to satisfactory levels in patients with a HbA1C greater than 10. 2. Maximum doses: Metformin 2500mg/day, Chlorpropamide 500mg/day, Gliclazide regular tablets 320mg/day, Gliclazide modified-release tablets 120mg/day, Glimepiride 4mg/day, Glyburide 20mg/day 3. Metformin: Intolerance – GI adverse effects: Contraindications – renal impairment (SrCr>130mmol/L) or hepatic failure, acute or chronic metabolic acidosis. 4. Sulfonylureas: Intolerance – Hypoglycemia: Contraindications – sulfa allergy, sever renal insufficiency (CrCl<50 mL/min).
8	For the treatment of Type 2 diabetes when: <p>Added on to metformin for patients: who have inadequate glycemic control on metformin: and who have a contraindication or intolerance to a sulfonylurea; and or whom insulin is not an option.</p> <p>Added on to Sulfonylurea for patients: who have inadequate glycemic control on Sulfonylurea and who have a contraindication or intolerance to Metformin; and or whom insulin is not an option.</p>
9	For the treatment Type 2 diabetes mellitus for patients with inadequate glycemic control on metformin and sulfonylurea and for whom insulin is not an option OR as an adjunct to diet, exercise, and standard care therapy to reduce the incidence of cardiovascular death in patients with type 2 diabetes mellitus and established cardiovascular disease (details must be provided as per clinical note below) who have inadequate glycemic control despite an adequate trial of metformin.

NOTE : Table 4.2 was updated May 2019

TABLE 4.2: TABLE KEY Continued

10	For the treatment of type 2 diabetes in patients for whom insulin is not an option AND who are already stabilized on therapy with metformin, a sulfonylurea and sitagliptin, to replace the individual components of sitagliptin and metformin for these patients.
11	For the treatment of patients with type 2 diabetes for whom insulin is not an option AND who are already stabilized on therapy with metformin, a sulfonylurea and linagliptin, to replace the individual components of linagliptin and metformin for these patients.
12	For the treatment of patients with type 2 diabetes for whom insulin is not an option AND who are already stabilized on therapy with metformin, a sulfonylurea and saxagliptin, to replace the individual components of saxagliptin and metformin for these patients.
13	For the treatment of patients with type 2 diabetes for whom insulin is not an option AND who are already stabilized on therapy with metformin and dapagliflozin, to replace the individual components of metformin and dapagliflozin for these patients. NS: Claim note: must have met criteria for dapagliflozin PE: For the treatment of type 2 diabetes for patients for who insulin is not an option and who are already stabilized on therapy with metformin, a sulfonylurea and dapagliflozin , to replace the individual components of dapagliflozin and metformin in these patients.
14	For the treatment of type 2 diabetes mellitus in patients who are already stabilized on therapy with empagliflozin and metformin, to replace the individual components of empagliflozin and metformin. Patients must meet coverage criteria for empagliflozin.

NOTE: TABLE 4.2 was updated May 2019

Table 4.3: Provincial Formulary Coverage of Injectable Combination Therapies & Indications for Use in Various Populations

Formulary Coverage	Indication for use with:								Therapeutic Considerations [■]
	NS	NB	NL	PE	ADULTS [■]	PEDIATRICS [■]	PREGNANCY [■]	LACTATION [■]	
INJECTABLE COMBINATION THERAPY									
Long acting BASAL insulin + GLP-1 Agonist									
<ul style="list-style-type: none"> Insulin degludec / liraglutide (Xultophy®) Insulin glargline / lixisenatide (Soliqua™) 	○	○	○	○	Type 2	Not for use less than 18 years	Contraindicated	Contraindicated	These agents have not been studied in combination with prandial (short acting) insulin.

● = Exception Status; ● = Full Benefit; ○ = Not a benefit

■ Reference: Product Monograph

NOTE: TABLE 4.3 was updated MAY 2019

Table 4.4: Non-Insulin Therapies and Insulin - Considerations for Use

The recommendations in the following table are made based on varying levels of evidence, ranging from randomized controlled trial (RCT) data to existing clinical practice. Each agent is referenced to indicate the rationale for the recommendations made regarding their use with insulin. Recommendations may change as evidence evolves.

NON-INSULIN THERAPIES Use with Insulin (in combination)	BOLUS INSULIN		BASAL INSULIN		PREMIXED		PREMIXED IAS		
	Rapid-acting IA	Short-acting (Regular insulin)	Intermediate-acting (NPH or Humulin N)	Long-acting IA • Detemir	Long-acting IA • Glargine	Ultra-long-acting IA • Degludec	Premixed Reg and NPH	Premixed IAS	
ORAL ANTIHYPERGLYCEMIC AGENTS									
Biguanides									
• Metformin ¹ (Generics, Glucophage®, Glumetza® once-daily formulation)	✓	✓	✓	✓	✓	✓	✓	✓	✓
INSULIN SECRETAGOGUES²									
• Sulfonylureas (Gliclazide®, Glimperide®, Glyburide®, chlorpropamide and tolbutamide)	X	X	✓	✓	✓	✓	X	X	
• Meglitinides: Repaglinide (Gluconorm®)	X	X	✓	✓	✓	✓	X	X	
DPP-4 INHIBITOR									
• Sitagliptin ³ (Januvia®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Saxagliptin ³ (Onglyza®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Alogliptin ³ (Nesina®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Linagliptin ⁴ (Trajenta®)	X	X	X	X	X	X	X	X	
THIAZOLIDINEDIONE									
• Pioglitazone (Actos®)	X	X	X	X	X	X	X	X	
• Rosiglitazone (Avandia®)	X	X	X	X	X	X	X	X	
SODIUM GLUCOSE CO-TRANSPORTER (SGLT2) INHIBITORS									
• Canagliflozin (Invokana®) ³	✓	✓	✓	✓	✓	✓	✓	✓	
• Dapagliflozin (Forxiga®) ³	✓	✓	✓	✓	✓	✓	✓	✓	
• Empagliflozin (Jardiance®) ³	✓	✓	✓	✓	✓	✓	✓	✓	
• Ertugliflozin (Steglatro™) ⁵	X	X	X	X	X	X	X	X	
ALPHA-GLYCOSIDASE INHIBITOR									
• Acarbose (Glucobay®) ³	✓	✓	✓	✓	✓	✓	✓	✓	
COMBINED FORMULATIONS									
• Metformin + Rosiglitazone (Avandamet®)	X	X	X	X	X	X	X	X	
• Metformin + Sitagliptin (Janumet®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Metformin + Sitagliptin (Janumet®XR)	✓	✓	✓	✓	✓	✓	✓	✓	
• Metformin + Linagliptin (Jentadueto®)	X	X	X	X	X	X	X	X	
• Metformin + Saxagliptin (Komboglyze®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Metformin + alogliptin (Kazano®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Metformin + Canagliflozin (Invokamet®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Metformin + Dapagliflozin (Xigduo®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Metformin + Empagliflozin (Synjardy®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Metformin + Ertugliflozin (Segluromet™) ⁵	X	X	X	X	X	X	X	X	
• Linagliptin + Empagliflozin (Glyxambi®)	X	X	X	X	X	X	X	X	
• Sitagliptin + Ertugliflozin (Steglujan™) ⁵	X	X	X	X	X	X	X	X	
INJECTABLE ANTIHYPERGLYCEMIC THERAPY: GLP-1 RECEPTOR AGONIST									
• Exenatide (Byetta®) ⁶	X	X	✓	✓	✓	✓	X	X	
• Exenatide extended release (Bydureon®)	X	X	✓	✓	✓	✓	X	X	
• Liraglutide (Victoza®) ⁷	X	X	✓	✓	✓	✓	X	X	
• Dulaglutide (Trulicity™) ⁷	X	X	✓	✓	✓	✓	X	X	
• Lixisenatide (Adlyxine™) ⁸	X	X	✓	✓	✓	✓	X	X	
• Semaglutide (Ozempic®) ⁹	X	X	✓	✓	✓	✓	X	X	
• Orlistat (Xenical®)	✓	✓	✓	✓	✓	✓	✓	✓	
• Liraglutide (Saxenda®) ¹⁰	X	X	✓	✓	✓	✓	X	X	

IA - insulin analogue; X - Not recommended for use with insulin - either due to lack of data or proof of harm; ✓ - Used with insulin in clinical practice

NOTE: TABLE 4.4 was updated MAY 2019

TABLE 4.4 Continued

FOOTNOTES

1. RCT data supports metformin as the standard of care in combination with insulin in T2DM.
2. Existing clinical practice: Insulin secretagogues may be continued while taking basal insulin to limit initial deterioration of glycemic control and because of their insulin-sparing effect, but the combination should be avoided later if hypoglycemia occurs and/or when bolus insulin regimens are added. RCT data to inform the secretagogues optimal place in therapy with insulin are lacking.
3. Monograph states: Indicated as add-on combination therapy with insulin.
4. Monograph states: Use in combination with insulin is not indicated due to a cardiovascular risk which cannot be excluded.
5. Monograph states: not indicated for use in combination with insulin.
6. Monograph states: Indicated as add-on combination therapy with glargine insulin [based on RCT data]. Exenatide is combined with detemir and intermediate-acting insulin in clinical practice despite a lack of RCT data examining these combinations [existing/emerging clinical practice]. The combination of exenatide and bolus insulin has not been studied.
7. Monograph states: Indicated as add-on combination therapy with basal insulin. The combination of liraglutide and bolus insulin has not been studied.
8. Monograph states: indicated in combination with basal insulin (alone or with metformin).
9. Monograph states: indicated in combination with basal insulin WITH metformin when diet and exercise plus basal insulin with metformin do not achieve adequate glycemic control
10. Monograph states: Saxenda® should not be used with insulin, as this combination has not been studied.
Note: Victoza® (also liraglutide) is indicated as add-on with basal insulin.

NOTE:

Clinical trials have studied the effects of newer non-insulin therapies (oral and injectable agents) combined with insulin, in treating high blood sugar levels, as compared to insulin monotherapy; however, at present, evidence is limited for all possible insulin combination therapies, in particular combinations with older oral agents.

NOTE: TABLE 4.4 was updated MAY 2019

SECTION 5: Documentation Forms

- Insulin Start Order Form
- Insulin Start Instruction Education Checklist

INSULIN START ORDER FORM

Please complete, and forward to the local Diabetes Centre

Addressograph Area

**This form
is for
information
only**

Current Diabetes Non-Insulin Therapies (oral and Injectables)

Medication Name	Dose/ Frequency	Continue	If continued, New Dose/Frequency	Discontinue	Date to Discontinue
		<input type="checkbox"/>		<input type="checkbox"/>	
		<input type="checkbox"/>		<input type="checkbox"/>	
		<input type="checkbox"/>		<input type="checkbox"/>	
		<input type="checkbox"/>		<input type="checkbox"/>	

Insulin (type, dosage, frequency, and time):

Special Instructions:

Authorization for Dose Adjustment: Yes No

Endocrinologist/Internist consult: Yes No If yes, to whom? _____

Consult already forwarded: Yes No

Prescription for Insulin and Supplies:

Provided to patient Comment: _____

Will be provided following insulin start appointment.

Date

Physician Signature

**INSULIN START INSTRUCTION EDUCATION CHECKLIST
DIABETES CENTRE**

INSTRUCTIONS:

- Instruction** Use columns under this heading to indicate the first time the topic was taught.
- Reinforcement** Use columns under this heading to indicate review of specific topics.
- Date & Initial** Record the date. Initial if required.
- C** Check (✓) when comprehension is adequate and reinforcement of topic is not required.
- H** Check (✓) if handouts/materials were given.
- F** Check (✓) if family/others were present for instruction.
- G** Check (✓) if topic was instructed in a group.

**This form is for
information only**

TOPIC	Instruction					Reinforcement					Reinforcement				
	Date & Initial	C	H	F	G	Date & Initial	C	H	F	G	Date & Initial	C	H	F	G
Insulin															
• name/type/time action															
• measurement (units)															
• storage/expiry dates															
• delivery devices o pen o syringe															
• preparation															
• site selection/rotation (exercise)															
• starting dose/expected dose adjustment															
• injection times															
Sharps Disposal															
Infection Control															
• single use needles															
Meal Timing/Snacks															
Hypoglycemia															
• causes															
• treatment/glucagon															
SMBG															
• times/frequency															
• target ranges/goals															
Non-insulin therapy (oral)															
• discontinue or continue															
Non-insulin therapy (injectables)															
• discontinue or continue															
Prescription(s)															
• supplies															
Follow-up Routine															
Other:															
• special aids															
• adjustment															

Demonstration—Preparation and Administration

Insulin	Demonstration (Date)	Return Demonstration (Date)	Return Demonstration (Date)	Comments
Preparation Single Dose ○ Pen ○ Syringe				
Mixed Dose				
Administration <input type="checkbox"/> Pen Needle tip size ____				
<input type="checkbox"/> Syringe				

Overall Comments:

Follow-up Plan:

Signature Initials Signature Initials

Signature Initials Signature Initials

**SECTION 6:
Glossary of terms
and
abbreviations**

Glossary of Terms

Algorithm	An insulin dose scale that provides a guide for making insulin dose adjustments to correct for immediate high or low blood glucose.
Anticipatory Dose Adjustment	Adjustment in advance of planned physical activity or food intake.
Basal Insulin Dose	Background insulin from a long-acting insulin analogue or intermediate-acting insulin to match background insulin need. In continuous subcutaneous insulin infusion (pump), is a continuous 24-hour delivery of insulin. When one or more basal insulin doses are correctly set to deliver 50% of the TDD, the blood glucose does not rise or fall during periods in which no eating occurs.
Basal/Bolus Insulin Therapies	Three or more injections of prandial (meal time) insulin, and 1-2 injections of basal insulin or continuous subcutaneous insulin infusion (CSII)/pump therapy
Bolus/Prandial	Delivery of rapid- or short-acting insulin to match carbohydrates in an upcoming meal or snack.
Certified Diabetes Educator	A health care professional who is trained, experienced, and competent in diabetes education and has passed a certification exam provided by the Canadian Diabetes Educator Certification Board.
Carbohydrate Counting	Counting the grams of carbohydrates in any food eaten and matching these grams with appropriate insulin doses; focuses on total amount of carbohydrates at each meal and snack.
Certification	Process to qualify the healthcare provider for safe, competent practice of an advanced skill.
Client	The person with diabetes requiring insulin.
Combination Therapy	Use of both insulin and non-insulin therapy (oral agents and/or injectables).
Compensatory Dose Adjustment	An adjustment to the rapid-/short-acting insulin dose to compensate for hypoglycemia or hyperglycemia.
Continuous Glucose Monitoring	An adjunctive method of monitoring blood glucose (complementary to self-monitoring of blood glucose)—rt (real time) and is (intermittently scanned—Flash Glucose Monitoring)
Correction Bolus	Insulin delivered to bring a high blood glucose back to target goals.
Dawn Phenomenon	An early morning rise in blood glucose levels caused largely by the normal release of growth hormone that blocks the effect of insulin during the early morning hours.
DESIGNATE (for exam purposes)	A diabetes educator previously certified in insulin dose adjustment with demonstrated competency and confidence who is formally (in writing) appointed by the Diabetes Centre Medical Advisor/Director to oversee the preparation and examination for insulin dose adjustment.
Flexible Insulin Therapy	Therapy that uses predetermined blood glucose targets and A1C values as goals. Insulin doses are adjusted according to blood glucose levels, food intake, and/or physical activity.

Glucagon	A hormone produced by the alpha cells of the pancreatic islet of Langerhans and a counter-regulatory hormone to insulin. It is injected during severe hypoglycemia to raise the blood glucose quickly by releasing glucose stored in the liver.
Glycogen	The form in which the liver and muscles store glucose. It may be broken down to active blood glucose during an insulin reaction, a fast, or exercise.
Gravida	Woman who is or has been pregnant regardless of outcome.
Honeymoon Phase	A remission phase that can happen within weeks of diagnosis of type 1 diabetes. This phase is characterized by a temporary recovery of beta-cell function during which time insulin requirements may decline.
Insulin Sensitivity Factor	Estimates point drop in mmol/L with a unit of rapid-/short-acting insulin.
Insulin-to-Carbohydrate Ratio	The amount of insulin required to cover a known amount of carbohydrate, keeping blood glucose levels within target two hours after the meal/snack.
Intensive Diabetes Therapy	The intensity of the effort an individual makes using self-management strategies to meet diabetes-related goals.
Intensive Insulin Therapy	Insulin regimens that are designed to mimic physiologic insulin aimed at achieving normal or near normal blood glucose levels.
Intercurrent Illness	An illness that is superimposed on diabetes.
Intermediate-Acting Insulin	Insulin that starts to work in 1 to 3 hours, peaks in 5 to 8 hours, and lasts approximately 18 hours (up to 24 hours in children).
Long-Acting Insulin Analogue	Insulin analogues that provides basal 24-42 hour coverage.
Meal Period	Includes a meal plus any snacks before the next meal.
Multiple Daily Injections	Insulin regimens involving three or more insulin injections a day.
Non-Insulin Therapy	Term used to describe non-insulin therapies used with diabetes. Includes oral anti-glycemic agents (OAGs) such as secretagogues, biguanides etc., and injectable therapy such as GLP-1 receptor agonists.
Para (Parity)	Number of pregnancies reaching viability; not number of fetuses delivered.
Pattern Management	Changes made to usual insulin dose based on blood glucose patterns.
Rapid-Acting Insulin	An insulin analogue that starts to work in 10 to 15 minutes, peaks at 1.0 to 1.5 hours, and lasts approximately 3.0 to 5.0 hours.
Sensor-Augmented Therapy	Combines the technology of an insulin pump with the continuous glucose sensor. The user has access to continuous, real-time glucose readings, enhancing the ability to make decisions around food, exercise, sick day/DKA management, etc.

Short-Acting Insulin	Insulin that starts to work in 30 minutes, peaks at 2 to 3 hours, and lasts approximately 6.5 hours.
Supplemental Dose Adjustment	Temporary insulin adjustments to the rapid-/short-acting insulin dose to compensate for hyperglycemia or hypoglycemia. Supplements can be additional insulin added to the usual dose or a “negative supplement” (i.e., a decrease in the usual dose).
Teratogen	An agent or influence that causes physical defects in the developing embryo.

Abbreviations

ac	before meals
AcAc	acetoacetate
BID	twice a day
BMI	Body Mass Index
CDA	Canadian Diabetes Association
CDE®	certified diabetes educator
CGM	continuous glucose monitoring system
CHO	carbohydrate
CSII	continuous subcutaneous insulin infusion (pump)
DCan	Diabetes Canada (formerly Canadian Diabetes Association)
DC	Diabetes Centre
DCPNS	Diabetes Care Program of Nova Scotia
DKA	diabetic ketoacidosis
DMF	Delegated medical function
ER	Emergency Room
GDM	gestational diabetes
A1C	hemoglobin A _{1c}
HB	3 beta-hydroxybutyrate
HDL	high-density lipoprotein
hs	evening or at bedtime (for the purpose of this resource)
IA	intermediate-acting insulin
is CGM	intermittently scanned (is) continuous glucose monitoring
ICU	Intensive Care Unit
ISF	insulin sensitivity factor
LA	long-acting insulin analogues

LDL	low density lipoprotein
MDI	multiple daily injections
mg	milligrams
mmol/L	millimoles per litre
OAA	oral antihyperglycemic agents
OGTT	oral glucose tolerance test
pc	after meals
PCOS	polycystic ovarian syndrome
PMA	premixed insulin analogues
PMR	premixed regular insulin
QID	four times a day
RA	rapid-acting insulin analogues
rt CGM	real time (rt) continuous glucose monitoring
SA	short-acting insulin
SMBG	self-monitoring of blood glucose
TDD	total daily dose
TID	three times a day
TMD	total meal dose
TSH	thyroid stimulating hormone
UKPDS	United Kingdom Prospective Diabetes Study